A Draft Documentary History of the Cranberry Iron Mine in Mitchell County, North Carolina

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Introduction

This is a draft documentary history of the Cranberry Iron Mine, from the time that General Robert Hoke acquired the property in 1867 until the last active mining operation closed in the 1960s. I have attempted to collect relevant documents and place them in roughly chronological order. I have also included the available relevant technical information on the equipment used in the mine. Perhaps more can be accomplished on this portion of the subject. I invite other members of the Historical Society to add any missing material to this document and discuss/correct any deficient interpretations of the information at hand (particularly the dating of photos). As drafted, my intent was to focus on the mine (not the railroad, town, furnace in Johnson City, or other iron mining operations along the railroad as this document is currently over 200 pages). For those who wish to research the documents and photos further, I have provided links to expedite such attempts when available. In general, I have left the original spelling (sometimes autocorrect strikes, so I am unsure that all of it is original). I believe this documentary history will support much analysis (e.g. accurate structural drawings and detailed timelines of changes in the facilities), which will make it possible to develop more accurate modelling of this fascinating operation. I wish to thank Chris Ford for his assistance and encouragement to bring this document into a presentable state.

For references that addresses iron mining in this area prior to 1867, see Appendix A, below. A list of open questions and missing references are given in appendices G and H, respectively.

May 1867. "Thomas D. Carter V. Robert F. Hoke and Others…

Motion to vacate an injunction, etc., before Henry, J., at Spring Term 1869 of Madison Court.

The action had been brought in August 1868, in order to rescind a conveyance made in May 1867, by the plaintiff to the defendants Robert F. Hoke, Thomas J. Sumner, E. Nye Hutchinson, George W. Swepson and Robert R. Swepson, of a valuable Iron Mine in Mitchell County, known as the Cranberry Iron-ore-bed; to have the defendants Charles W. and Francis B. Russell, who had bought from Hoke and his associates, and also Samuel W. Williams and J.C. Hardin, who otherwise, and previously, had connexion with the title, declared to be trustees of said property for the plaintiff; and, in the mean time, to have a receiver appointed, etc.

The pleadings were very elaborate; especially the answer of Hoke, Sumner, Hutchinson, which covered 98 pp. of foolscap.

All that seems necessary to state here, is, that the plaintiff charged that the defendants first named above, had contrived a scheme to defraud him of the property in dispute, of which he owned much the larger interest, and that, after deluding him with many negotiations upon the subject, at last they agreed to pay him $44,000, cash, for his interest; that, upon his tendering the deed, they, after making divers excuses, offered him a sight draft upon a bank in New York, which they represented to be upon funds deposited by them there, and that he, with some

reluctance, received it; that, upon presentation, it was protested, and has never been paid; that the drawers are insolvent; and have since sold the land to the defendants, the Russells, etc…"[1]

1867. "Brown et al. v. Cranberry Iron & Coal Co…

Certain persons, Hoke, Sumner, and Hutchinson, had become the owners of a tract of land in North Carolina, known as the 'Cranberry Iron Ore Bank.' They offered it for sale in 1866 or 1867 to parties in New York. Before negotiations for the purchase were concluded, it was discovered that J. Evans Brown, one of the parties in this case, and A.C. Avery, as executor of Isaac T. Avery, claimed an interest in the minerals in the land. As the proposed purchasers were buying the land chiefly for the minerals in it, this claim induced them to break off negotiations. Thereupon Hoke, Sumner, and Hutchinson opened negotiations with Brown and Avery looking to the extinguishment of their claim, so that they could renew their negotiations with the persons in New York, and offer to them a perfect title… Then follows a full description of the lands by metes and bounds. Habendum: 'The one-half of the mines and mineral interests in said lands and the appurtenances thereto belonging' to Sumner and Hoke in fee. The consideration paid to Avery, executor, was $17,000; that to Brown, $22,000. These deeds having been executed, the purchasers, thinking they had a clear, unincumbered title in fee, completed the sale to the parties in New York, and, by mesne conveyance from the latter, the property has been conveyed to the defendant, the Cranberry Iron & Coal Company. This transaction between Brown and Avery, executor, with Hoke and his associates, was in 1867. The coal and iron company, having purchased, went to great expense in developing the mineral resources of the property, erecting buildings, constructing a railroad, and sinking shafts. But they have not actually mined, beyond a test or so, any of the land east of the road or path. They have been in actual use and cultivation of the whole surface."[2] For a complete extract of this article, see Appendix B, below.

Note: "The Cranberry mine property went through a series of complicated transactions following the [Civil] war. Former Confederate General Robert F. Hoke owned the operations for a number of years…"[3]

23 December 1867. "Letters from North Carolina – V. Messrs. Editors – I will leave Buncombe for a while, at the request of some of your readers, to tell them about Yancey and Mitchell counties; to give them some particulars respecting the 'iron ore,' and about the 'railroad' now being constructed in that vicinity. The lands are similar with Buncombe, but much richer. There are beautiful fertile valleys; very productive hills and mountains; water courses innumerable, affording immense water power, and the streams abound with speckled trout and other fish. The timber in most localities is of a superior growth of white oak, spotted oak, poplar, locust, sugar and curled maple, cherry, papaw, shellbark hickory, mountain mahogany, black Walnut, white pine, &c. The climate is very salubrious; is a little colder than Buncombe, and not quite so dry. The elevation is higher above tide. The country is quite thickly settled, though it is not extensively cleared. The people are generous hearted, but not cultivated. Apples and all the fruits I have mentioned in Buncombe, together with the cereals and grasses, and all root crops grow splendidly. I cannot speak of the cultivated grape; there are no vineyards; but the wild grape is of luxuriant growth. A gentleman (surveyor) told me he once found a magnificent vine running along a rocky steep, laden with ripening fruit; that he measured it and found it was seventy yards. Cranberries grow wild in abundance, and the strawberries are finer than in Buncombe. The country is especially adapted to grazing; all kinds of stock do well as possible. The lands are

covered with a natural growth of exuberant herbage upon which sheep and cattle feed and fatten during three-fourths of the year.

About the 23d of last December I was travelling on horse-back, in company with my husband, en route from East Tennessee, over the great Smoky or Iron mountain, through Yancey, Mitchell and other counties, to Buncombe, and had opportunity of visiting many localities, and of seeing much that was interesting; noticed the cattle feeding in the fields or around the hay-stacks, and many little flocks of sheep scattered over the mountains, browsing on the steeps or lying cozily under a clump of evergreen, which serves them for shelter during the storms of winter. All were fat and fine. Geese were everywhere in the pastures and about the streams. Turkeys, chickens and other fowls were seen in goodly numbers around almost every homestead. We heard nothing of the wolf nor of its kindred, but saw the beautiful pheasant with its spotted plumage. We visited 'Cranberry,' that celebrated mountain of ore, and rode upon its summit; observed its wealth of mineral, and exclaimed in astonishment, what a mighty mass of iron! What a source of good to the people! Why does it lie here idle! We rode over the country, and went into ecstacy over the natural beauties around us, and selected many lovely spots where could be made sweet homes among the evergreens and by the side of laughing waters. We saw many other banks of similar ore surrounded by charming places for settlement, and wondered why the people should flock to the 'West,' instead of coming to this beautiful South! Cranberry iron is distinguished by its great magnetic properties. It is equal to, if not superior to the best Swedes iron. For all purposes where hard, tough iron is required, it is preferable, being equal to American steel when case hardened. It possesses all the toughness of the 'Juniata iron' of Pennsylvania, and is just as malleable. The ore has been tested, and is highly recommended for making fine steel. We are told that it has been reported on at the ordnance department at Washington, and pronounced the best article discovered in the United States for guns of all calibre. This iron was used during the late war by the confederate government for making guns, and its qualities were found of superior excellence. Axes were made of this metal as a substitute for steel. Because of its peculiarly strong magnetic properties, it is highly recommended for all railroad purposes. It is thought that one incalculable advantage would be, that were a road made of this iron, as also the engine and car wheels, a much greater force would be requisite to throw the train from the track. I would respectfully solicit the attention of scientific men to this supposition, and would urge it upon public notice.

The ore is easily obtained from the banks. One man can take out from three to six tons per day. It yields from sixty to eighty per cent. of pure metal. Some of these iron properties are very desirably located; lie from one to five miles from the railroad (surveyed) route from Johnson to Morganton; can be bought on very reasonable terms, with small or large bodies of land and water power to suit purchasers. Price of land varies from one to ten dollars per acre. The highest price lands are valley lauds, very level and of superior quality, and the timber is magnificent. Yancey and Mitchell counties are in the extreme western part of North Carolina, and lie on the Tennessee State line…

The road from Johnson to the North Carolina State line is being built, and when completed, will be within a short distance of the lands and minerals of which I have been speaking. Tennessee is pushing her railroad forward to this mineral region, but North Carolina has not yet done anything more than grant a charter for its extension. It is expected that her Legislature will act in this matter as soon as it comes before them, as it will be greatly to the interest of the State. I am just in receipt of a letter from a correspondent at the 'Roan Mountain,' a northern gentleman located there, and will take an extract from his letter:

'I am in the backwoods, among the wild cattle at resent, indeed, but the railroad is coming! It is being built now; it will be within six miles of here next summer, and in eighteen months the cars will be rumbling through. It is said that when completed it will form part of an important through route—shorter than any other either built or projected between the West and the South. My cattle are thriving finely on the range.'

In reply to inquiries, I will say there are no iron works in operation in Western North Carolina, while everything used by agriculturists made of iron or steel is greatly needed throughout the country. Plows, in particular, are very much wanted—just such quality as the cranberry iron will make, equal to steel, and peculiarly adapted to use in the mountains. The people want stoves, and castings of every kind for domestic use are in demand.

We very sincerely hope that enterprise will find its way to this region of country, and that people from all quarters will flock here in goodly numbers and make for themselves pleasant homes among the grand old mountains of this good North State. Truly a good State, beautifully blest! but lacking in enterprise, as the people must see when a woman [?] takes up her pen to tell about lands and minerals and railroads.

I will cheerfully answer all private inquiries pertaining to my letters.

Mrs. Wm. J. Brown.
Ashville, N.C., July 14, 1868"[4]

25 August 1869. The Raleigh Weekly Standard.[5]

"State Fair – Interesting Features… Among others, R.F. Hoke, who was born and raised in the midst of iron workers will read a paper on the 'Cranberry Iron,' said to be found in enormous deposits in Mitchell county, and found by experience to be equal to the Danemora Iron of Sweden. This will no doubt be an able and instructive paper."

29 June 1870. Knoxville Weekly Chronicle.

"Car Wheel Manufactory. Some time ago Messrs; Clark, Quaife & Co. leased the celebrated Cranberry Iron Works, in Carter county, which, we are informed by an old railroad man, is the only iron in this county, known at present, to be adapted to the manufacture of car wheels. It is the best quality of brown hematite, and when mixed with other iron is equal to the best wheels manufactured at Wilmington. Delaware, and are sold cheaper. When mixed this iron retains its toughness and chill, and will wear twice as long as those made North."

28 February 1873. "An Act to Incorporate the Cranberry Iron and Coal Company.

Section 1. The General Assembly of North Carolina, do enact, That Robert F. Hoke, Thomas J. Sumner, Charles W. Russell, Moses L. Holmes, William Murdock, Samuel H. Wiley and Matthew O. Beatly, and such other persons as shall be associated with them, their successors and assigns, be and they are hereby created a body politic and corporate, by the name and title of the Cranberry Iron and Coal Company…

Sec. 4. Be it further enacted, That said company shall have power to purchase, lease or otherwise, mineral lands, and to work the same for the extraction of iron ore, coal or other

minerals or products; to manufacture iron and all products of iron or other minerals and transport the same to market…

Sec. 6. That said company shall have the right, power and authority to lay out, build and construct roads, whether rail train, plank or turnpike, for the successful transportation of iron ore, coal, coke, iron, mineral and all products found upon their land, and also to construct such dams as shall be needful for the supply of water to their mills, manufactories and furnaces, the drainage of their mines, or for any other purpose found necessary; to erect bridges over streams of water whenever necessary, and to connect such with the railroads of any company now incorporated, or which may be hereafter incorporated by the laws of this State, at any point the said company may select for such connection, and such roads shall be open to the use of the public upon the payment of such reasonable tolls and subject to such rules and regulations as said company may establish… Ratified the 28th day of February, 1873."[6] See Appendix C for the complete text of this document.

"According to a local resident, when [General Robert] Hoke came on the scene, he was able to purchase the entire township 'for a little gray mare and a rifle gun.' On February 23, 1873, the Cranberry Iron Mine Company was chartered by the state of North Carolina. Two days later, Hoke was elected secretary of the corporation. Among his partners was Ario Pardee, a Philadelphian who dominated much of the coal and iron market on the East Coast."[7]

1874. "Former Confederate General Robert F. Hoke… and his associates incorporated the Cranberry Iron and Coal Company in 1873. The property was sold to a group of Pennsylvania investors in 1874."[8]

9 October 1874. Wilmington Journal.

"The Hickory Press says: It is rumored that McClung & Co., a wealthy firm of Knoxville, have bought the eighteen miles of Railroad between Johnston's Depot, on the V. & T. Railroad, in Tennessee, and the Cranberry Iron works, in North Carolina, and propose to complete it at once to the latter point."

3 May 1875. The Charlotte Democrat.

"We have been told that the celebrated Cranberry Iron works have been recently sold for $150,000. We have not learned the name of the purchaser. It is also stated that Maj. Brown has sold his mineral reservations in Mitchell county for $20,000. Who will now doubt the great mineral wealth of Western North Carolina? – Ashville Expositor."

5 May 1875. Knoxville Whig and Chronicle.

"A New Railroad Enterprise. A Contemplated Improvement of Great Importance. We understand that the Pennsylvania Steel Company has recently purchased the East Tennessee and Western North Carolina Railroad. This is the same that is sometimes known as the Mineral home Road. The same company has purchased that valuable property in Carter county, the Cranberry iron works. The road connects with the East Tennessee, Virginia and Georgia

Railroad at Johnson City, and is already graded for several miles, the exact distance we do not now recollect. It is about twenty miles from Johnson City to the iron works above alluded to. The Cranberry iron is famous all over the country for its superior qualities, and in the hands of a company with a capital sufficient to develop and work the mines, they must become the most profitable in the whole country.

We understand that at the next term of the Chancery Court at Jonesboro', a charter will be applied for, enabling the company to construct either a narrow gauge or a broad gauge road, and that work will be commenced as soon as the charter is obtained. If this is true, it will open up an inexhaustible quantity of the best iron in the United States."

20 August 1875. Nashville Union and American.

"The West North Carolina Railroad. Baltimore Sun: Gen. A.E. Jackson, President of the East Tennessee and Western North Carolina Railroad, which taps the East Tennessee, Virginia and Georgia Railroad at Johnson City, Tenn., made a sale of that unfinished improvement last Wednesday to Messrs. Pardee, Hoke & Co., who have obliged themselves to complete it as far as now graded against Sept. 1, 1877. These gentlemen have also purchased the Cranberry iron property, the objective point of the improvement on top of Unaka mountain, paying therefor $175,000 down. The firm is composed of Mr. Pardee, of Philadelphia; Gen. R.F. Hoke, of North Carolina, and others, and they are said to represent $20,000,000."

"Hoke and Pardee realized that modern transportation was needed to efficiently and profitably move iron ore from the mountain mine to furnaces and markets. The solution to their dilemma was the East Tennessee and Western North Carolina Railroad Company, a defunct corporation chartered by the state of Tennessee in 1866. Hoke and his associates purchased the railroad for twenty-five thousand dollars on September 10, 1875; in time, Hoke would become president of the railroad. Work commenced immediately to construct a narrow-gauge line stretching twenty-four miles across the mountains from Cranberry to Johnson City, Tennessee… Hoke maintained ownership in the railroad and mining operations in the Cranberry area for several decades."[9]

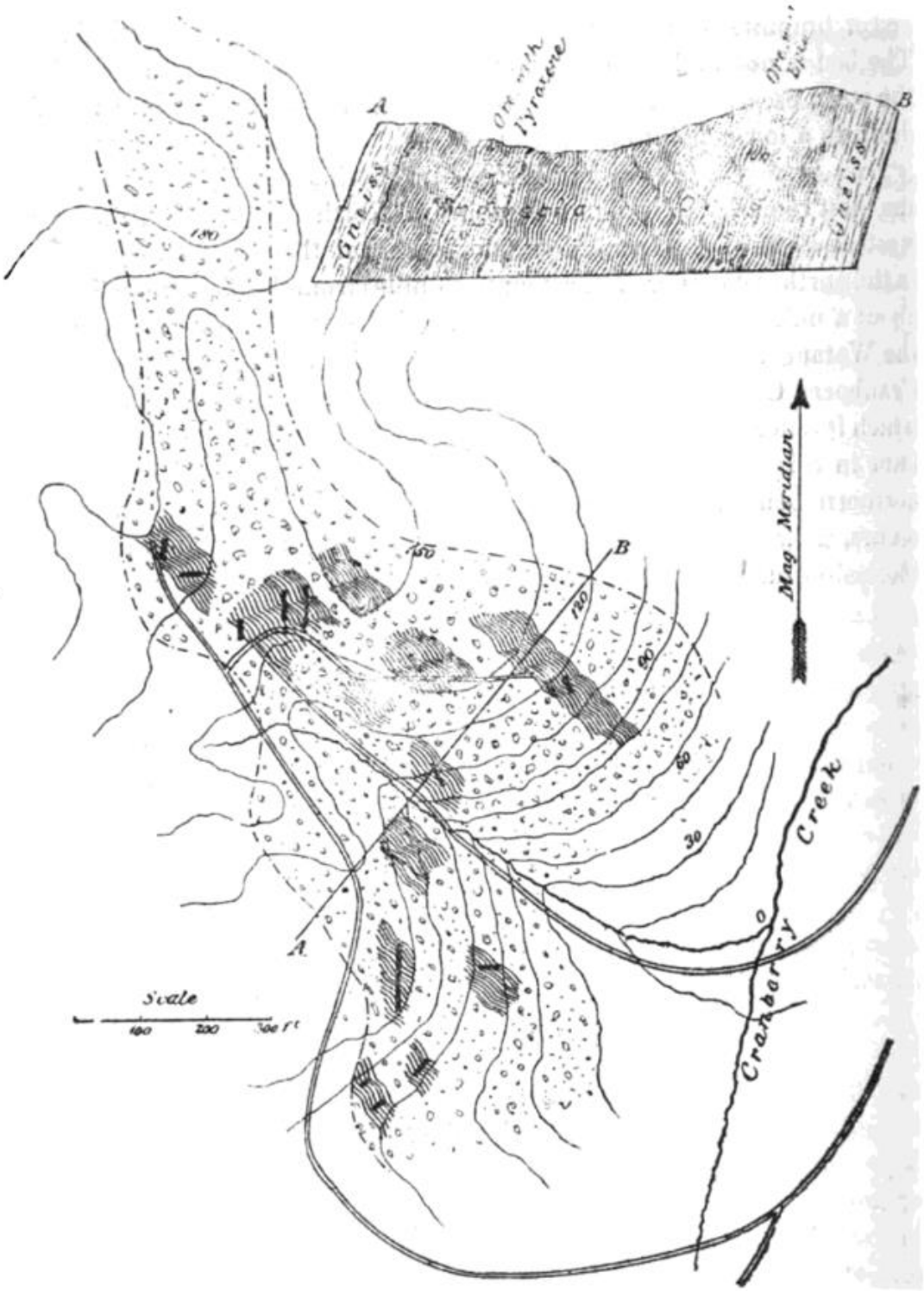
15 September 1875. The Morristown Gazette.

"E.T.&W.N.C. Railroad. The Bristol Courier learns from Gen. R.F. Hoke that the company with which he is connected has purchased the E.T. & W.N.C. Railroad. It is expected that the trade will be consummated in a day or two. By the terms of the purchase the road is to be completed to Doe River Cove in two years. It will be changed to a Narrow Gauge, and built to the Cranberry Iron Works as soon as the times will permit."

1 October 1875. Report of the Geological Survey of North Carolina, Volume I, by W.C. Kerr.

"Iron Ores of Mitchell and Ashe. – In Mitchell county is found one of the most remarkable iron ore deposits in North America. It lies on the western slope of the Iron Mountain, (a part of the Great Smoky range), in the northeast corner of the county, 3 miles from the Tennessee line, and about a mile from the rapid torrent of Elk River, the principal affluent of the Watauga. It has been long known as the Cranberry Ore Bank, from Cranberry Creek, which

flows at the foot of the steep mountain spurs, on which it outcrops. The prevalent and characteristic rock of the mountains in this locality is hornblende slate and syenyte, and it is on the northern margin of a mountainous ledge of such rocks, that the ore-bed occurs, gray gneisses and gneissoid slates coming in beyond in immediate succession and association, in part.



[Figure 1.] Cranberry Ore Bank

The ore is a pure magnetite, massive and generally coarse-granular, and exhibits strong polarity. It is associated with pyroxene and epidote, in certain parts of the bed, as shown in the appended diagram. The steep slope of the mountain gorge and ridges which the bed occupies, are covered with blocks of ore, often of hundreds of pounds weight, and in many places, bare vertical walls of massive ore, 10 and 15 feet thick, are exposed, and the trenches and open diggings, which are scattered, without order, over many acres of surface, every where reach the solid ore within a few feet of the surface. The length of the outcrop is about 1500 feet and the breadth 200 to 800, – 600 in the section given in the diagram. A large quantity of ore has been quarried and smelted here during the last two or three generations, but no mining has been done, the loose and partly decomposed and disintegrated masses of ore and magnetic gravel mixed with the surface earth, having been preferred by the ore diggers, as being more easily obtained, and much more readily stamped and granulated for the forge fire. The quality of the ore will best be seen by reference to the following analyses:

	64	65	66	67	68
Magnetic Oxide of Iron,	94.37	91.45	85.59	80.77	91.89
Oxide of Manganese,	0.26	0.06	0.24	1.42	0.32
Alumina,	0.42	0.77	0.11	0.52	1.03
Lime,	0.43	1.01	0.72		1.06
Magnesia,	0.36	0.53	0.33		0.23
Water,		0.44	1.53	8.21*	1.15
Silica, Pyroxene, &c.,	4.16	5.74	11.48	9.08	4.02
Sulphur,					0.25
Phosphoric Acid,					trace
	100.00	100.00	100.00	100.00	99.95
Metallic Iron,	68.34	66.22	61.98	58.49	66.53

The first four of these analyses are by Dr. Genth, who says ‘the first three samples contain neither titanic acid, nor phosphorus and sulphur, the fourth contains a trace of phosphoric acid.’

No. 68 was made in 1869, by Prof. Chandler, of Columbia College, New York city, who remarks: ‘This is the best iron ore I have ever analyzed. It is very rich in iron and very free from sulphur and phosphorus.’ The smiths and farmers of the region will use no other iron, if the Cranberry can be had, and they willingly pay fifty per cent. more for it than any other in the market. The softness and toughness of this iron is very remarkable, and its tensile strength, as tested by the United States Ordnance Department, ranks with that of the best irons known. The blooms from the Cranberry forges have been extensively used in Baltimore for boiler iron, and commanded fifteen dollars a ton above the market. In quality it is unsurpassed by any iron in the world. And in regard to quantity, the bed much exceeds the great deposits of Missouri and Michigan, and at least equals anything in the Champlain region. So that it has not probably an equal in this country. It has been recently sold to one of the leading iron manufacturing companies of Pennsylvania, for $175,000, and when they shall have completed the branch railroad, thirty miles in length, from the ore to the East Tennessee & Virginia Railroad, no doubt the iron world will begin to hear of the deposit in a practical way.

The topographical sketch of this ore-bed was taken rapidly and roughly, with a mountain level and pocket barometer, and of course lacks accuracy of detail, but the main features and

measurements are approximately exact. The epidote is not entirely confined to a single stratum, or part of the bed, being mixed to some extent with the pyroxenic rocky gangue which most abounds towards the western side of the vein.

There are other magnetic ore-beds in the neighborhood of less extent…"[10]

20 April 1878. "Magnetic Iron Ores of the Unaka Mountains, N.C. and Tenn. Special Correspondence Engineering and Mining Journal.

A note appeared in the Journal of March 25 [23], saying that Gen. Pardee and others are already at work constructing a narrow-gauge railroad from Johnson's City, Tenn., on the East Tennessee Valley & Georgia Railroad, to Cranberry Forge in North Carolina. As this ore region may exert a very important influence on the iron manufactures of Tennessee, and particularly of the Chattanooga and Knoxville Districts, the writer has thought that a few notes which he has made concerning these ore deposits will be of interest at this time.

Those who are familiar with the iron deposits of Tennessee, Georgia and Alabama which are within reach of water or railroad transportation, know that, almost without exception, the percentage of phosphorus which these ores contain is so high that they are unfitted for making either Bessemer steel iron or neutral foundry iron. At the two or three localities in Georgia and Alabama, where ores low in phosphorus are found, the only fuel available is charcoal; and the comparatively small amount of pig iron made from them commands a high price for car wheel and other chill-casting purposes.

In every other respect except this fatal amount of phosphorus, the limonite and fossiliferous ores of these States are well adapted for making all kinds of merchantable iron, and if an ore rich in iron and free from phosphorus could be supplied at not too great a cost, this general Southern district would be able to make any and all kinds of iron, and at a minimum cost.

The immediate incentive to the building of the above-mentioned railroad is undoubtedly due to the demand of the Roane Iron Co., of Chattanooga, for steel-making pig iron.

They have now in process of erection two Siemens-Martin furnaces, with which they soon expect to make ingots for steel rails.

The only supply of iron ore, low enough in phosphorus to answer their purpose, which, up to the present time, they have been able to command, is that from the neighborhood of Cartersville, Ga., where there are a number of thin, nearly vertical seams of specular ore, which much resemble the specular ores of Lake Superior. This ore is expensive to mine, and contains a high percentage of silicious matter. At Cedartown, Ga., about thirty miles from Cartersville, there are extensive beds of limonite ore, which are said to make an iron low enough in phosphorus for steel-making; but the distance of these beds from railroads and from any coal supply almost precludes their use at present. Some charcoal pig iron made at wn from these ores may be used at present.

These uncertain and expensive sources of ore supply will hardly enable the Roane Iron Co. to make their steel as cheaply as is necessary, and, in consequence, they hope to draw on the deposits of magnetic ore which are situated in the Unaka Mountains of East Tennessee and Western North Carolina. For many years the ore deposits of this region have supplied a number of old-fashioned Catalan forges or bloomery fires, and the resulting iron has been of such a superior quality as to have attracted special attention. The ores to be reached by the railroad now in process of construction are situated in Carter County, Tenn., and Mitchell and Wautauga counties, N.C.

As one leaves the railroad at Johnson's City and goes east toward the mountains, the lower Silurian limestone is first crossed, and then the Chilhowee sandstones, which are succeeded by the metamorphic rocks. The upper series of these rocks is then crossed, until what Dr. T. Sterry Hunt, after a careful examination made last summer, pronounces to be true Laurentian rocks, are reached, and in these rocks the magnetic ore is found. Here, for a distance of over thirty miles, magnetic ore has been mined for use at the charcoal forges, and desultory magnetic observations also show the presence of ore at many points which have not been worked.

The general topography of the belt, from Cranberry Forge, the terminus of the proposed railroad, to Joe River to the southwest, although mountainous, is not rugged, and while the elevations range from three to six thousand feet above sea level, the surface of the country is covered with a most luxuriant timber growth.

Those who are familiar with charcoal iron making in the North, will find it hard to believe that mountain land can yield an average of eighty cords of wood to an acre, and in exceptional cases even one hundred and forty cords, or that a second growth of fifteen years could yield sixty cords to an acre.

But those who go there can see these things for themselves.

Although the writer spent over a week in examining this belt of ore territory, its extent was so great that time could only be given to the examination of those points where ore had been worked, or there were supposed out-crop indications. Commencing at Cranberry Forge, in North Carolina, there is found, about three-quarters of a mile southwest of the forge, a spur of a hill, about 300 ft. high above the stream at its base, and here most of the ore which has been used was mined. The surface of this spur is covered with pieces of dense magnetic ore, weighing from five to fifty pounds, and mixed with boulders of gneissoid rock. The ore has been worked at a great number of points on the spur, and, as the forgeman who acted as cicerone said, 'You dig most anywhere and you will find ore.' The general impression produced by a careful examination of these numerous workings was, that without exception the ore masses consisted of lenticular deposits, varying in extent from a few to several hundred tons. In no instance at this point was there any visible evidence of a continuous bed or deposit.

The fact that so much ore is found on the surface and that the forge has been supplied for so many years from this one point produce the impression that the amount of ore is endless. Those who bear in mind what Iron Mt. in Missouri has proved to be will not be likely to give too much weight to fine surface displays of boulder ore, and when one considers the small amount of ore required by a bloomery of two or three fires even for fifty or a hundred years, other evidence is required to prove the existence of large quantities of ore.

The ore is intensely magnetic, and often is highly polaric, so that occasional strong attractions of the dipping needle simply show the immediate presence of small ore masses. The quality of the ore is most excellent, as will be seen from analyses Nos. I, II and III, which fairly represent its quality in this portion of the belt.

Going southwest from Cranberry now, for about eight miles, one finds at various points indications of ore, and at several points old workings, and in connection with these frequent strong attractions of the dipping needle. At this distance is Hampton or Crab Apple Forge, which, like the one at Cranberry, is of ancient mention. In the immediate neighborhood of this forge there are numerous workings where ore has been removed, which duplicate, in general character, those seen at Cranberry. The ore, as there, is rich in iron, and occurs, apparently, in isolated masses embedded in hornblendic gneiss. About a mile southwest of the forge, and at several

hundred feet elevation above it, is what is claimed to have been a true bed of magnetic ore, which has been opened and worked.

An incline was driven some distance on this ore, but, owing to its having given way near the surface, it was not possible to investigate it. There seemed to be a conflict of opinions, on the part of those who had worked in it, as to its nature, some considering it as a chimney or shoot deposit, and others as having considerable lateral extent.

In the absence of cross gangways of any considerable length, this question seems still in doubt. The ore here is not as rich as it is generally found, and is said to produce a red short bar iron, which is certainly not due to the presence of sulphur. It is attributable, perhaps, to the silicon present in the ore. From this point onward, till Little Rocky Creek is reached, there are occasional strong magnetic attractions shown by the dipping needle, and in one or two instances surface indications of ore. The most important of these is from two to three miles from a forge recently erected on Little Rocky Creek. Here an opening has been made in a side-hill, exposing a face of ore from four to fifteen feet thick and about thirty feet long. It dips considerably, and has been uncovered but a short portion of its apparent depth.

Above and below the ore are decomposed gneissoid rocks, and one rock above the ore has the appearance of a decomposed basalt. Following the general line of this opening up the hill, it is said that a dipping needle shows an ore outcrop, and at the top of the hill several superficial excavations have shown some ore. The chemical character of the ore is shown by analysis No. V in the table. It will be noticed that this ore contains a considerable percentage of titanic acid, which will affect its quality for blast furnace purposes.

In the Catalan forge the ore seems to work as well as that containing no titanic acid.

Beyond Rocky Creek there are indications of similar ore, but no developments have been made. A seam of specular ore, parallel in general direction to the magnetic belt, lies on the west side of this. Its surface development is good, but as yet its content of silica is too high to warrant its development.

The district containing these ore deposits is about thirty-four miles long, and is owned in five large tracts. The Cranberry property, owned by Pardee, Firmstone & Co., has an extent of 2½ to 3 miles on the ore belt, and contains about 3,500 acres of land.

The Stewart property, adjoining, has from 2½ to 3 miles on the ore belt, for which there is mining right only. The Crab Orchard Iron Co.'s property adjoins that last mentioned, and has 4½ miles of the ore belt, and 16,000 acres of land.

Next is the Magnetite Co., who have 1½ miles of the ore belt, and 7,000 acres of land. The last and largest property is that belonging to Rees & Wilder, of Chattanooga, who own 18 miles of the ore belt, and 143,000 acres of land.

It should be stated here that these figures are only approximate, as no accurate surveys have been made of the territory in question..."[11]

"Although the railroad now building is expected to have an eastern connection from North Carolina at some future time, the only source of profit for the immediate future must be in the traffic derived from the development of iron industries. The question is pertinent as to whether enough is known of the extent and quantity of iron ore in the district which has been described in this article to warrant the expenditure of from one to two hundred thousand dollars for building the railroad. Summarizing briefly, we have two points on a long range of territory where ore has been mined in a small way for nearly if not quite a century. Altogether, it is not probable that 50,000 tons of ore have been mined in this time, and in getting this amount there

have not been developed any signs of a large ore body. On the extreme southwestern tract there is a promising appearance of a considerable seam, but this is only an appearance as yet, owing to its not having been opened to any extent. Outcrop indications, as far as the writer has seen, do not seem to promise large ore deposits. At many points the dipping needle shows a strong attraction, but those who are well experienced in this kind of operation know too well that isolated and unsystematic work with the needle has often led over-confident and hasty operators to financial wreck.

The writer believes that the parties who are now at work have commenced at the wrong end, and, while the ultimate result may be a successful one, it, on the other hand, may not.

Exploitation is a word that has slowly been grafted into our language. Its significance and importance have not yet been apprehended and appreciated to their most beneficial extent. Some day money must be spent to open the ore deposits at Cranberry. Why not spend some of it at first, and prove what are now really nothing but surmises and generalizations?

Setting aside the manufacture of fine bar iron for use in making the best grades of crucible steel, the business of the new railroad must almost entirely consist in the transportation of ore. The present market for the ore is practically confined to Chattanooga, which is 249 miles from the terminus of the road. At one cent per ton per mile, the freight would amount to $2.49 per ton. This is not as low a rate as some of the Southern roads give for ore transportation, but even if not more than $1.50 per ton were charged, the cost must be very low at which the ore is put on the cars, to compete at Chattanooga with 50 per cent. ores, which will sell for $1.75 per ton.

There must be no truffle-hunter's method of mining them.

The cost of mining ore to make iron that sells for five cents per pound, is quite another matter than when the iron only brings one cent a pound. Let abundant and cheaply minable ore be assured, and the future of the railroad and the region will undoubtedly be a very successful one.

A projected railroad from the Ohio River to Johnson's City, by way of the Big Sandy River, will make the whole region tributary to the Ohio dependent upon the Cranberry district for its steel-making ores, if the condition of cheap mining can be realized.

This established, and the road completed, an impetus will be given to the manufacture of fine iron by the Swedish process, which in time may grow to be a business of considerable magnitude.

The chemical analysis of the ores, and the quality of the bars made by the rude Catalan process, have proved that as fine steel-making material can be produced from these one as is now imported to the United States to the extent of over 40,000 tons per annum.

The enormous timber growth with which this district is covered will supply a cheap and, in this case, owing to the rapidity of re-growth, an inexhaustible supply of cheap fuel. With the not very expensive local ore and limestone from the Tennessee Valley, pig iron and then bar iron can be produced, which should rival in quality and undersell the best now brought from abroad. The adoption of this process would remove what, with many steel makers, has hitherto been an insuperable objection to American bar iron – its want of uniformity.

The Cranberry district gives indication enough to encourage the hope that there is abundance of ore there, but is it not best to prove that fact before the railroad is built?

Don't unlock the stable to find that there never was any horse inside.

Analyses of N.C. Magnetic Ore by Dr. Genth

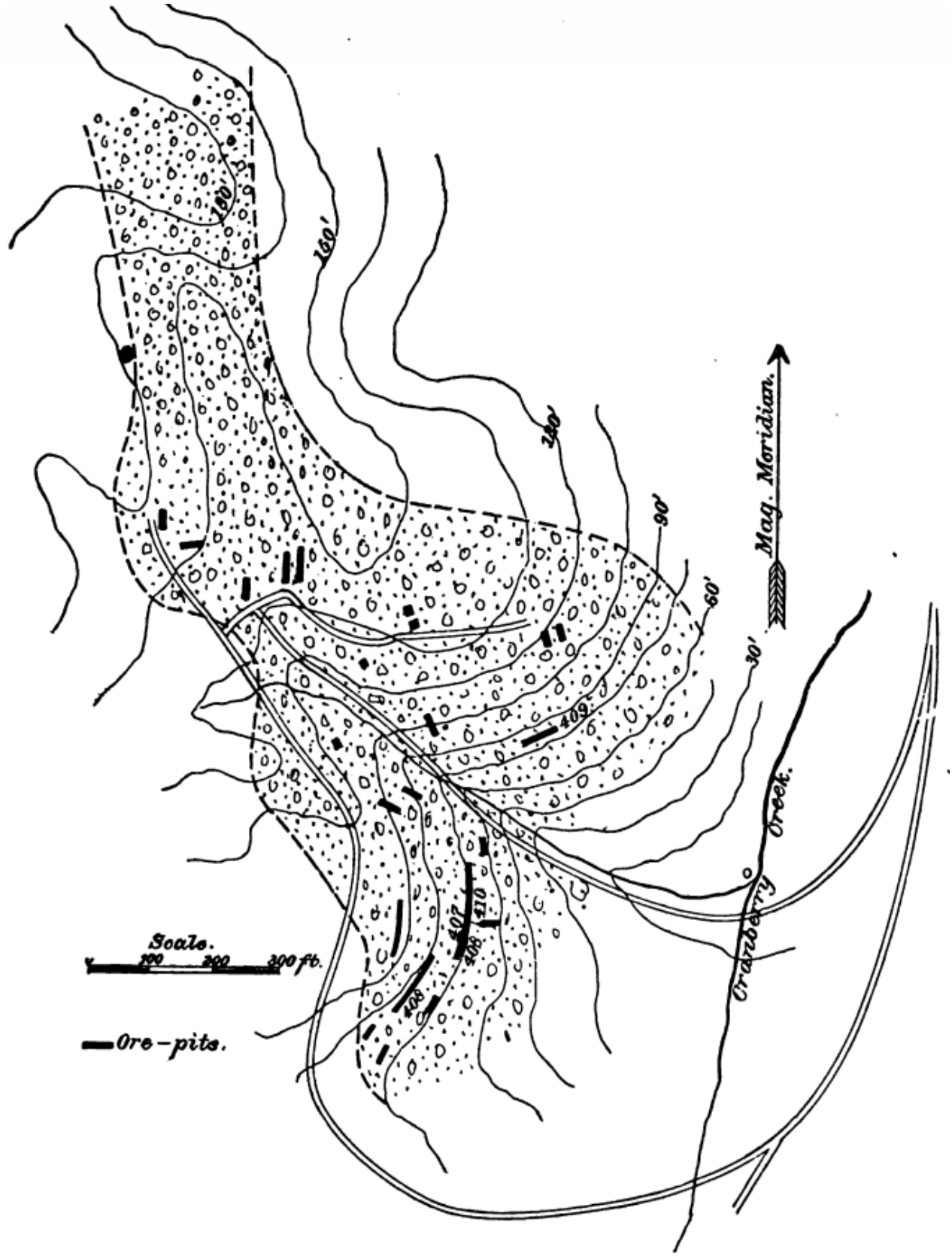
	I.	II.	III.	IV.	V.	VI.*
Fe as Fe_3O_4 and Fe_2O_3	68.34	69.08	67.63	58.19	67.89	64.62
Mn_2O_3	.26	.24	.27	1.42	.25	
Al_2O_3	.42	.38	.41	.52	.34	
MgO	.36	.33	.35	Trace	.30	
CaO	.43	.39	.41	Trace	.27	
SiO_2 and silicates	4.88	4.43	4.68	9.08	3.72	
TiO_2					5.87	
P_2O_5	Trace	Trace	Trace	Trace	Trace	Trace
O, H_2O, etc.	25.30	25.15	26.25	30.79	21.36	
S						.027

* A.J. Preusse, analyst."[12]

April 1880. Report on the Mining Industries of the United States…

"The following sketch, taken from Kerr's Report for 1875 (p. 264), gives the general outlines of the deposit and the contours of the steep ridges, upon which are located the shallow diggings that have furnished ore for the Cranberry forge. No mining has ever been done and all the old pits, except those on the southeastern pitch, marked 407, 408, and 409, are caved in; in the absence of outcrops the limits of the bed have therefore to be determined by the distribution of surface fragments. These are found, as shown by Professor Kerr, on the highest ridge, and are more or less thickly scattered over the hillside down to the creek. ["Since this locality was visited a railroad has been completed to Cranberry, and extensive mining operations are now in progress."]

At the time the bank was visited, April, 1880, there were several cuts extending around the hill at about the 60- to 75-foot contour line from the road on the southwest to the little brook; there were also several openings on the other side of the brook in which the ore was exposed."[13]



[Figure 2] "Sketch of the Cranberry Ore-bank, North Carolina. From Kerr's Report for 1875…"

Figure 3. "Over two dozen men can be seen (if you look very carefully with a magnifying glass) mining iron at three levels of the Cranberry mine in the 1880s. All mining at Cranberry at this time was done in surface pits. A few years later mining moved to a large tunnel that tapped the ore vein. Most of the other mines along the Cranberry iron belt were smaller open pits."[14]

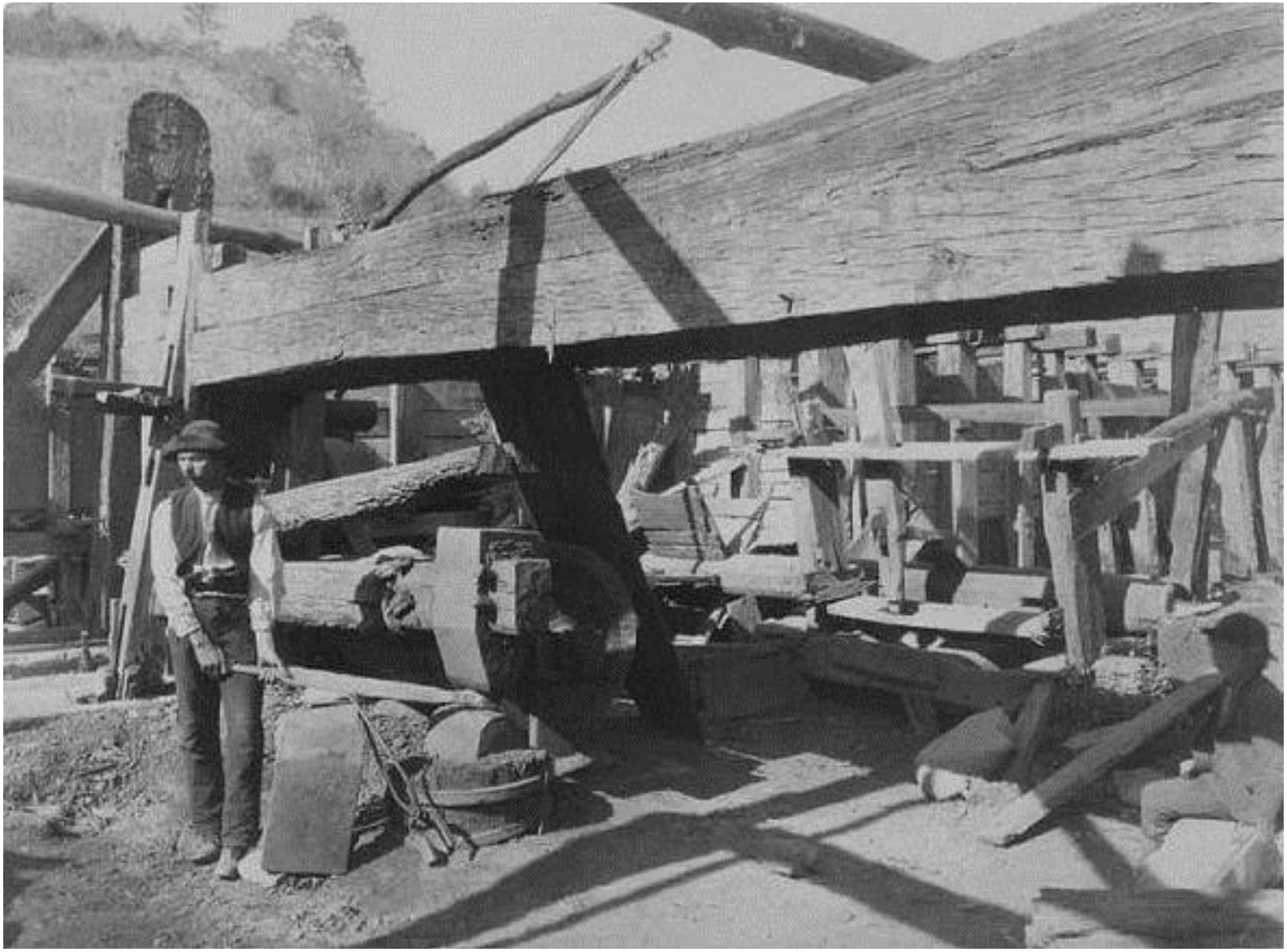


Figure 4. “Early catalan forge on the north end of Cranberry” Chris Ford.
“North Carolina… Cranberry Forge, Mitchell county. Product, bar iron for local use, made from ore.”[15]

Figure 4a. Another photograph, at the same facility as above.[16]

19 August 1881. The Charlotte Democrat.

"Cranberry Iron and Coal Company. This valuable property is located in the rough and rugged county of Mitchell in the valley between the Blue Ridge and Iron Mountains, and about 32 miles from Bakersville, the county seat.

The company was incorporated under the laws of North Carolina. They own five thousand acres of land. The ores taken from this property are what is known as magnetic iron and is the very best of the kind. The average value per ton by assay is 68 per centum of metalic iron. There are five veins, the width of which are as follows: First, 20 feet; second, 6; third, 30; fourth, 25, and fifth, 34. All of these are included within a distance of 177 feet. They are working three huge tunnels, one of which (the main one) will cross cut at right angles all five of these veins. This main tunnel is 14 feet in the clear, 11 feet at the top and 8 high. It is calculated to use mining cars and mining locomotives in this tunnel.

The old workings were conducted in a different manner. They skimmed the tops of the veins where exposed, taking up the soft, partially decomposed ores and smelting them at a forge. This practice has been discontinued.

Contractors are now engaged in building thirty-five houses. A town has been laid out in regular streets, and when the buildings are completed the appearance of the place will be greatly enhanced.

Nearly all the grading on the company's Railroad from Johnson City, Tenn., to Cranberry, is completed and it is expected that by this time next year the Road will be finished and in operation. Salisbury Watchman."

1881. Iron and Coal of Tennessee, by Joseph Buckner Killebrew.

"Carter County. About two miles northwest of Cranberry occurs a small ridge, the water-shed between the waters of Elk creek and Doe river. Both are tributaries of the Watauga. The head waters of Elk creek pass through Cranberry cove; those of Doe river take their rise in Crab Orchard cove, which lies in Tennessee, and is the counterpart of Cranberry cove. The dividing ridge is near the line between the States of Tennessee and North Carolina. Crab Orchard cove extends seven miles northwesterly, is elliptical in form, and is bounded by numerous lofty elevations which have local names. The magnetic vein can be graced all along the southwestern side of the cove, often cut by ravines, but appearing in the next elevation. While the quantity of ore in this magnetic vein would be equal to any probable demand, there are not wanting rich beds of brown hematite in Doe river valley. Six miles above Elizabethton the mountains recede, leaving a large cove, beautiful in its magnificent surroundings. This is known as Doe river cove. Some half dozen good banks of brown hematite have been opened on the slopes of the mountains environing this cove. These brown ores give by analysis about 48 percent. of metallic iron, with a small per centage of sulphur and phosphorus. These banks are in a range of mountains, the continuation of Iron Mountain of Carter and Johnson, and of the Chilhowee farther south. A furnace, the old stack of which is still standing in excellent state of preservation, was once run on these ores by Mr. O'Brien. It is located about three miles from the ore bank, on Doe river, and the fall is so great that no dam is required. A large tree now grows out of the top of the stack, and the whole surroundings, with the wildly rushing water and grand mountains, afford a scene eminently worthy of the artist's pencil.

On Doe river, three miles above Elizabethton, is Smith's forge, owned by Hon. B.R. Smith & Bro. They make bar iron during the winter months from the ore in the mountains around

Doe river cove. All this region will be fully developed by the East Tennessee and Western North Carolina Railroad, now being constructed from Johnson City, by way of Elizabethton, up Doe river to the Cranberry iron mines in North Carolina.

Stoney creek enters the Watauga four miles above Elizabethton, and its head waters are in Cross Mountain, having a length of over twenty miles. Almost continuously, in the ridges near its banks, are beds of both red and brown hematite iron ores, some of them of singular purity .and excellence. The immediate valley of this creek-is of limestone formation, which occasionally rises into isolated knolls; on each side are mountains of Potsdam sandstone, which at some points obtrudes itself into the valley. The mountain on the east is called Iron Mountain, and is continuous, only cut by streams; that on the west is called Holston Mountain; it is merely a long spur of Iron Mountain, and ends entirely a little north of the Watauga river. On the sides of both these ranges, and in the limestone hills of the valley, are the deposits of iron ore. This limestone is the lowest of the Lower Silurian limestones, is that classed in the Missouri Geological Reports as the Third Magnesian Limestone, and is the receptacle in that State of the great lead deposits of Mine LaMotte and St. Joseph. An ore of peculiar character is found for many miles in the loot-hills of Holston Mountain, on the west side of Stoney creek. It is a compact red hematite, rhombohedral in structure, with well denned angles; on exposure to the air taking a bluish gray or black blue color. It occurs in a series of beds or pockets up the valley, even into Cross Mountain, being above one series of the sandstones and conglomerates, and overlaid by colored and white sandy shales. It has been opened extensively only at the Cannon bank, and cannot be said to have been by any means thoroughly tested there.

The yield of this ore in the common Catalan forge—with water blast—is about 900 pounds of bar iron to the ton of ore used; 100 bushels of charcoal were used in the production of 250 pounds of iron. This ore was used for many years in a forge on Stoney creek, and the iron made from it highly esteemed. It is a true red hematite, and there is every probability that it can be found in paying quantities. Requiring a higher degree of heat, and in fact a differently constructed stack from the limonites, it has not been used in the Carter furnace.

Carter furnace is eight miles above Elizabethton, and four above the mouth of Stoney creek. It is supplied with ore chiefly from the Taylor bank, though also using from some other beds. The Taylor ore has been used for many years, and occurs in a somewhat peculiar situation. The entire area of about 20 acres is covered with chimney-shaped limestone rocks, giving it a resemblance to the sacrificial fields of the Druids in France and England. These stones are adherent to the solid stratum from five to twenty-five feet below. The ore is found in a clayey matrix between these upright stones. It is dug and washed for $1.50 per ton. The cost of coal is five cents for 20 pounds. From 180 to 200 bushels of charcoal are used to make a ton of pig iron, and the average daily product is 4½ tons. The usual charge is from 90 to 95 per cent. of iron ore, and 5 to 10 per cent. of manganese. The product of this furnace, being used entirely for car-wheels, it is thought that the manganese adds to the chilling property of the iron, also making it tougher. In practice it has been found that less limestone is needed when manganese is used, but some is thought necessary. Manganese ore is abundant in the mountain side, and it is thought that ferro-manganese could be made with considerable profit at this point…"[17]

5 April 1882. The Bulletin of the American Iron and Steel Association.[18]

"Chattanooga, Tenn., April 3. – The Cranberry Iron Company has discovered on its property in Mitchell county, N.C., two veins of the finest magnetite ore – one of eighteen feet,

and the other thirty-four feet. They have tunneled through the veins in building a railroad. There is much rejoicing among the iron men here, as it insures to the Chattanooga mineral district an abundant supply of steel-making ore."

6 April 1882. Memphis Daily Appeal.

"Chattanooga Times: '…The Cranberry Iron Company, who are building a new railroad from Johnson City, in upper East Tennessee, on the East Tennessee railroad, thirty-two miles to their property, in Mitchell county, N.C., have been tunneling for ore the last eight months. Their enterprise has been rewarded by striking two splendid veins of the finest magnetite, one of eighteen feet and one of fifty-four feet in thickness…'"

15 April 1882. Scientific American.

"Iron Ore in North Carolina. Chattanooga, Tenn., is rejoicing in the discovery. In Mitchell County, N.C., of two veins of magnetite of superior quality, one eighteen feet, the other thirty-four feet wide. The veins were cut while tunneling for a railway on the property of the Cranberry Iron Company. This discovery insures, it is thought, an abundant supply of steelmaking ore for the Chattanooga district."[19]

27 June 1882. Memphis Daily Appeal.

"The East Tennessee and Western north Carolina railroad is now completed from Johnson City, Tenn., to Cranberry, N.C. By this route a fine view of the mountains of Tennessee and North Carolina can be had. Roan mountain, in all its grandeur, looms up at a distance of eight miles from Roan Mountain station. From the terminus it is but a short distance to the falls of Elk and Linville falls. Tourists not desiring to 'rough it in the mountains' can return to Elizabethtown or Johnson City in the evening by train. This road will bring the celebrated Cranberry magnetic ore into market." The railroad to Cranberry officially opened on 3 July 1882.

Spring 1882. "Reminiscences of the North Carolina Mountains…

The East Tennessee & Western North Carolina Railroad, better known by its less imposing name, 'The Stem Winder,' a narrow gauge road thirty-four miles in length, running between Johnson City, Tenn., and Cranberry, N.C, had recently been completed. This road was originally a State and local enterprise, but it was abandoned after ten miles were built from Johnson City to Elizabethton. The franchise was then passed to Pennsylvania parties – Ario Pardee, a pioneer in the development of the coal and iron industries in the Lehigh Valley, a broad-natured man whose benevolence added to Lafayette College Pardee Hall, which was twice destroyed by fire; J. Gillingham Fell (his partner), at one time President of the Lehigh Valley Railroad; William Firmstone, Superintendent of the Glendon Iron Company; Frank Comly, President of the old North Penn Railroad, John A. Wise, its Secretary, and other officials of that line, now a part of the Reading system. It is understood that the franchise was a present, with a bonus included, provided the parties to this agreement would complete the road to Cranberry, where a large deposit of superior iron ore existed. They did this, and the 'Stem Winder' in due

time wound and climbed its way over gorges, through tunnels and picturesque ravines to its destination, Cranberry, 3,300 feet above sea-level.

There is no more romantic and picturesque scenery to be found on any line of its mileage than can be seen from this compact little stretch of railway of thirty four miles. The ruins of Parson Brownlow's forge are yet crumbling in the beautiful Wautagua Valley, and in it is President 'Andy' Johnson's homestead, which he was wont to call 'the garden spot of the earth,' and no one will combat his opinion who sees it when its massed bloom of rhododendron and tree honeysuckles and other wild flowers are riant in the spring. When the 'Stem Winder' begins its climb into the mountains, a succession of such lovely views is revealed that it startles the novice with delight. This 'Stem Winder' is a very deliberate railway, its train schedule being 10½ miles per hour, thus giving its patrons time to enjoy the scenery. The motive of the road was the iron mines at Cranberry, which are still operated by the company. Frank Firmstone, of the late Glendon Iron Company, was president of the road until recently, and John A. Wise, the very last leaf of the old North Penn officials, has always been and is still its secretary and treasurer. Mr. Wise is enjoying a hale old age, and his duties at his old stand in South Third street, Philadelphia, are no more onerous than financing the 'Stem Winder'' and seeing that the Reading comes to time with its leased obligations of the old North Penn, which is one of the mints of the Reading's system.

My first trip over the 'Stem Winder' was during the spring of its completion [in 1882]. Cranberry had then but its iron mines, a saw-mill, a few squalid cabins, and the old plantation house – a log cabin kitchen with a primitive two-story attachment, which Gen. Pardee, the son of Ario Pardee, and his associates had comfortably fitted up for their headquarters when visiting there. They courteously gave me the keys and the privilege of the frame end during my stay there. The first night proved quite an exciting one. I was awakened by a crackling noise coming from the log kitchen, which I credited to fire, and as it seemed one of more vigor than any ordinary fireplace could yield, and there being no other sounds, I promptly concluded to investigate. Sure enough, flames were making lively headway within the kitchen around an ash barrel, into which live coals had evidently been emptied with the ashes. I at once aroused the occupants, and they were quickly at work per axes, and bucket brigade from a little stream a hundred yards away. I then ran to the saw-mill and soon had all the men there at work in the fire department. The household effects from the frame end were all set out. Energy and absence of wind confined the flames to the kitchen and they were finally subdued, and the 'effects' were returned to their places, excepting one case of wine, which was apportioned to the firemen for immediate use on the premises. During this and the following season the company put up a moderate sized, handsome hotel, with rooms downstairs and up panelled with the native hard woods – walnut, cherry, oak and ash – including open tiled fireplaces and other modern improvements. The uncompleted building was put in charge of the company's mine superintendent for the winter, a capable and energetic man from Dover, N.J. Toward spring he concluded to employ some of his leisure in advancing what he considered the unfinished interior of the hotel, so he sent to Knoxville and got some kegs of white lead and set himself to putting a priming coat of white paint on the beautifully panelled hard woods. Fortunately Gen. Pardee and Wise arrived before the work had progressed ruinously far, and they blocked their good-intentioned superintendent very suddenly, and perhaps they did not also make the atmosphere about the hotel as blue as those mountain skies!..."[20]

2 August 1882. The Bulletin of the American Iron and Steel Association.[21]

"The Cranberry Iron Mines – General Wilder, who has just returned from the Cranberry ore beds, where he made a careful examination of the mines and beds, is enthusiastic over the magnificent find, and regards it as one of the most valuable iron ore mines in the country. The vein is now being cut across a distance of seventy feet, and it is thought it will reach a thickness of 120 feet. This is as good ore as exists anywhere, being thoroughly reliable for steel-making purposes and for 'fix' for puddling cold-short ores. The vein is nearly twice as thick as the Iron Mountain vein in Missouri, and is probably as large as any ever discovered. The supply seems perfectly inexhaustible, and the out-crop of one mile seems but an indication of the inconceivable mass of ore beneath. The company has now invested $1,000,000 in the ore lands and the railroad, and is preparing to mine on an extensive scale. Rand drills and air compresses are put in use, and preparations are making to mine at least 1,000 tons per day. – Chattanooga Times."

23 October 1882. "Narrative of the Third Annual Meeting of the United States Association of Charcoal Iron Workers, October 18 to 21, 1882…

The Cranberry Ore Deposit of North Carolina.
John Birkinbine, Esq., Editor Journal:
Dear Sir:

I think the members of the Charcoal Iron Workers Association who did not make the trip from the Chattanooga meeting to the 'Cranberry' mines, will like to know something of that excursion.

Without taking time or space for much detail, and with no waste of 'spread-eagle' description, allow me to give those who could not accept General Wilder's courtesy a brief sketch of what we saw on Monday, October 23 [1882].

Leaving Johnson City by special car on the East Tennessee and Western North Carolina railroad, narrow guage, we ran for several miles alongside the Wetauga river, a narrow stream, in a valley well cultivated, among steep hills mostly covered with hard wood, chiefly oak. The rock is limestone and in great abundance. This section was settled more than a century ago from Virginia and Pennsylvania, and at the battle of King's Mountain, in North Carolina, in 1780, about two hundred of the early inhabitants of this region assisted in routing the tories who had gathered in aid of Cornwallis.

The road soon turns into the narrow valley, often a mere gorge of the Doe river, a clear, narrow, rapid, mountain stream. Here we find the Potsdam sandstone, and again, after a time, limestone. The soil is fertile, well suited to grazing, and the sheep and cattle we saw were good and in good condition.

This railroad runs south-easterly into the Bald mountain, about 35 miles, extending into the edge of North Carolina, and is known as 'The Stem-winder.' For 4 miles along Doe river the grade is 150 feet to the mile, and the rise from the Wetauga river the entire length of the roads, is about 2,300 feet. The curves are as sharp as it is possible to make and not transform them into angles. We pass through 5 rock tunnels, and thread along mountain shelves, the noisy stream 50 feet below us, and the cliffs rising almost perpendicularly 400 feet above us, while at every turn new and lofty mountain peaks, often faced with rocks, set at every possible angle and covered with a wealth of hard-wood timber, rise before us. The scene is one of wonderful beauty and

wildness. The train has 2 or 3 flat cars going up for lumber, and at a water station, where a mountain spring is run by wooden spouts directly from the rocks into the locomotive tank, the party leaves the passenger car, and improvising board seats, take to the flats, and there get the full beauty of autumn sky and mountain, rock and river. Starting about 7 o'clock, we make the 35 miles about 11 o'clock, and enter the tunnel where the Cranberry Coal and Iron Company are mining the black oxide ore, valuable for making an iron convertible into steel. With little mining lamps in hand, we penetrate the blackness of darkness and see where the drills, run by compressed air, make places for dynamite and giant powder to do the work which once was slowly wrought out by pick and wedge and hammer. The tunnel is in about 400 feet, and is now drifting right and left along the heavy masses of ore. We saw pieces said to be over 70 per cent, in richness, and certainly wonderfully heavy. I should think the mineral would run over 50 per cent. We were fortunate in having of our party Professor Colton, Assistant State Geologist, and a Captain Jenkins, who knows every rod of that country, worked these ores years ago in a bloom fire, and whose practical knowledge of the minerals and mountains is to be relied on thoroughly.

At present, the ore is being run out by cars and sold, but works for reducing it on the ground are soon to be put up by the company. The mountains are covered with a heavy growth of wood and timber, in some parts virgin forest, and charcoal land cutting 30 to 50 cords per acre is very plenty. The timber hunter, our destroyer of forest wealth and beauty, the one to whom our older sections owe, in a large measure, their drouths and freshets, is there, and the black walnut, the cherry, and the ash is being ruthlessly slaughtered, and going on the cars both east and west. Large quantities of yellow locust is being split into 'tree nails' and sent to the ship-yards, even as far as Nova Scotia, while the laurel root is being dug out by the ton for pipes. Deer have all gone, now and then a bear is killed, while smaller game is plenty, and trout fishing still good. A fine 'string' was taken by a boy while we were at the mines, and General Wilder carried away this prize for the benefit of the party. Besides his interest in these mines, the general has a large private estate on the summit of Read mountain, the most lofty peak of this range, rising 6,486 feet above sea level, reached by wagon road 12 miles from the railroad station Wilder.

In 1822 iron was first made from this ore, the digging being on the surface right above the present tunnel. In 1847 the old forge was remodeled, and its ruins still remain. Here bars were drawn out under a rude hammer, and purchasers came from miles away, payment being almost invariably in truck, scarcely ever in money.

About the middle of the P.M. we again took the train for return through this wonderfully wild and beautiful country, voted by all the party to be the most delightful of all the pleasant excursions, and many times it was said that those who failed to be of our party could never dream of what they had missed.

To General Wilder, who was alone instrumental in getting up this most pleasant excursion, and to whom all owed a day of rare and unalloyed enjoyment, most hearty thanks were given, and after a bountiful supper at Johnson city, reached in the early evening, and a couple of hours spent in the great parlor of the 'City Hotel' in music and games and a genuine good time, the excursionists separated on opposite trains, and the Chattanooga meeting of the iron workers was at an end.

Yours hastily,

M. Lyman, Jr."[22]

17 March 1883. The Engineering and Mining Journal.

"Furnace, Mill, and Factory… Ground was broken for a new furnace at Cranberry, North Carolina, on March 3d. Among the gentlemen present were Gen. A. Pardee, Jr., General Hoke, C.H. Nimson, John S. Wise, and George Richards, James H. Simpson, and Augustus C. Canfield, of Dover… The great mine at Cranberry is doing well, and has about 5000 tons of ore on hand. It recently shipped 1500 tons of the ore to Allentown, to be used in the manufacture of Bessemer pig."[23]

8 June 1883. Transactions of the American Institute of Mining Engineers.

"On Friday [8 June 1883] the trip was resumed westward on the Norfolk and Western Railroad and over the East Tennessee, Virginia and Georgia Railroad, to Johnson City, Tennessee, where the narrow-gauge cars of the East Tennessee and Western North Carolina Railroad were in waiting and conveyed the party through wild, mountainous scenery to the Cranberry Mine (in North Carolina), of the Cranberry Iron and Coal Company. On arrival, General A. Pardee, Jr., President of the Company, received the members, who were given opportunity to inspect the underground workings. The party then returned to Roanoke, arriving about midnight."[24]

8 June 1883. The Engineering and Mining Journal.

"Next morning (Friday), an early start was made for Cranberry. What member of the Institute had not heard of Cranberry before? A special train, on this as on other occasions kindly provided by the Norfolk & Western Railroad, took us over the Norfolk & Western Railroad, and the East Tennessee, Virginia & Georgia Railroad to Johnson City, Tenn. where we found another train, composed chiefly of observation-cars, waiting to convey us to Cranberry. The Cranberry mine, the property of the Cranberry Coal and Iron Company, is located on the north slope of Hump Mountain, Mitchell County, N.C. The mine is reached by the East Tennessee & Western North Carolina Railroad – a narrow-gauge road 3 feet wide, with 40-pound iron rails – 34 miles east from Johnson City. The heaviest curves on the railroad are 18 degrees; and the heaviest grade, going east, 150 feet to the mile for two miles, and, going west, 80 feet to the mile for a short distance. The railroad follows first the Watauga River and then the Doe to its head-waters. The scenery is magnificent, and beggars description. At the mine, the elevation is 1500 feet above Johnson City and 3250 feet above tide. The mine is worked by tunnel which goes through gneiss rock, etc., for 220 feet, and then through hornblende and associated minerals to ore. Five or six machine drills are in operation, worked by compressed air. The daily output of the mine is at present 140 tons, and from ten to twelve thousand tons of ore have already been mined, a large proportion of which has been shipped to furnaces in the Lehigh Valley of Pennsylvania. The ore appears to be of good quality, and will doubtless make a first-class Bessemer pig-iron; for all the analyses show it to be comparatively free from phosphorus. We returned to Roanoke in the evening, greatly delighted with our trip…"[25]

1883. Hand-book of the State of North Carolina, Exhibiting its Resources and Industries.

"The following notices of the Chapel Hill and Cranberry mines were furnished by Mr. W. B. Phillips, Assistant Geologist… The Cranberry Iron Mine, in the northwest corner of Mitchell

county, employs sixty hands and ships principally to Allentown, Pa., where the company's furnaces are. The product now is one hundred tons per day; preparations are making for shipping two hundred and fifty tons per day."[26]

19 April 1884. The Johnson City Comet.

"Blowing in of Cranberry Furnace. On Monday April 14th at 4 o'clock p.m. the torch was applied to the new Furnace, at Cranberry, N.C, by Gen'l. Pardee, President of the Cranberry Iron & Coal Co. Gen. Hoke, of N.C, and a number of other gentlemen connected with the enterprise were present, Mr. Jno. S. Wise, Secty. of the Co. made the following address:

'We are here to witness and participate in the ceremony of lighting the fire which puts in operation the pioneer furnace of the Cranberry Iron & Coal Co., an important event in the progress of the company, and the development of its property. All of us are more or less familiar with the obstacles, difficulties and trials that have been surmounted in arriving thus far in our progress.

The completion of the Railroad and successful development of the mines have tasked the energy of all concerned. Many of less faith would have fallen by the way, but with a devotedness of purpose on the part of all, these results have been achieved, and the furnace stands to-day a monument to their indomitable courage and perseverance. May the fire thus kindled serve as a beacon to light the way to other and grander achievements, which will add to the prosperity of the 'Old North State' and inure to the greatness of our whole country. In view of these results of the company's enterprise, we feel at liberty to ask in the presence of one of North Carolina's distinguished citizens, the influence of the State to continue the mantle of protection over her varied industries, to the end that her mountains, abounding with inexhaustible mineral wealth will respond to the effort of the miner, and her valleys yield generously to the husbandmen the fruits of his toil – and now as the smoke ascends in ringlets to the skies, we kindly invoke for success of the furnace the best wishes of all.'"

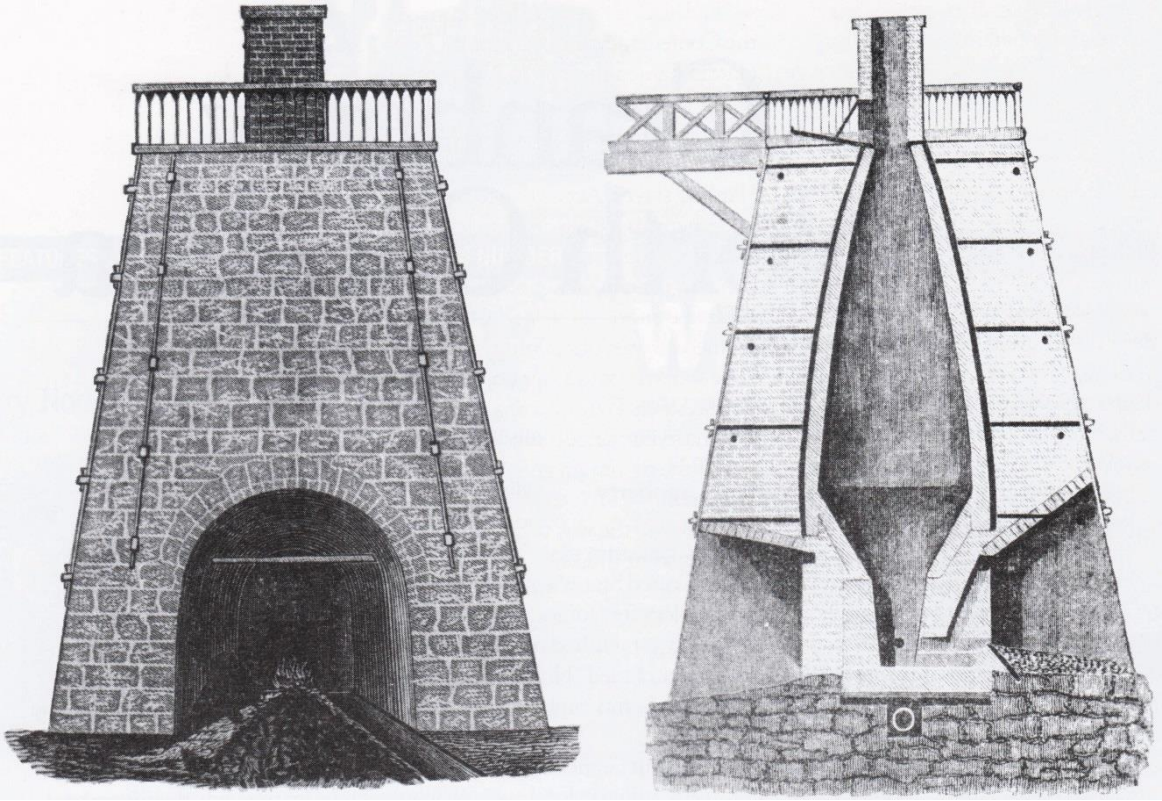


Figure 5.
Left: "Front view of an old-style charcoal furnace similar to the original furnace at Cranberry."
Right: "Section view of the same old-style cold blast furnace looking into the tuyeres."[27]

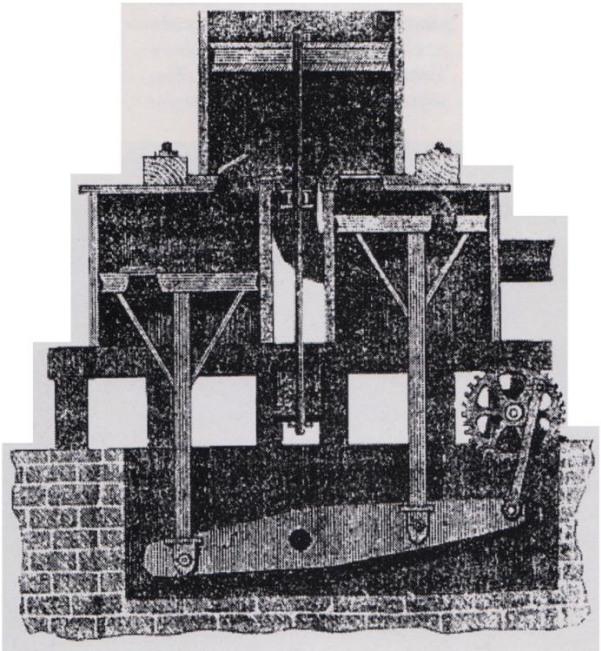


Figure 6. "An example of a wooden cylinder bellows, similar to one used at Cranberry. It was driven by a waterwheel." An 1892 report noted: "one double-cylinder water-wheel blowing engine; diameter of cylinders 4 feet, stroke 5 feet, revolutions per minute 4¼ to 4½."[28]

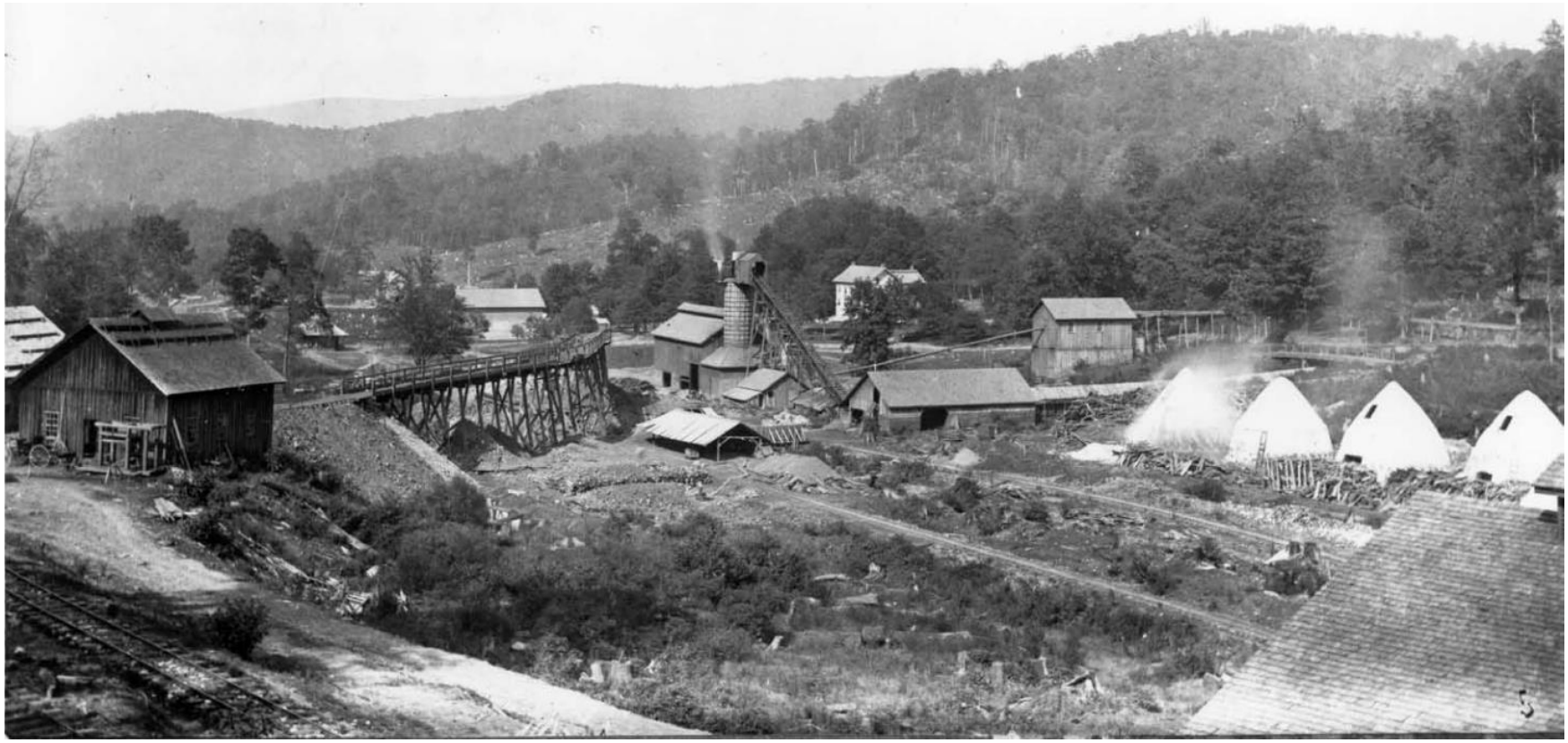


Figure 7. "Old Charcoal Furnace Cranberry N.C." "Cranberry furnace using charcoal and hot blast circa 1890," by Chris Ford. Also captioned: "In the mid-1880s, ore from the mine is hauled to the small iron furnace in the center of the valley. Charcoal ovens supply the fuel for the furnace. A water-driven blower is in the building to the right of the furnace. Photo by Edgar P. Earle, Allen Curtis Collection."[29]

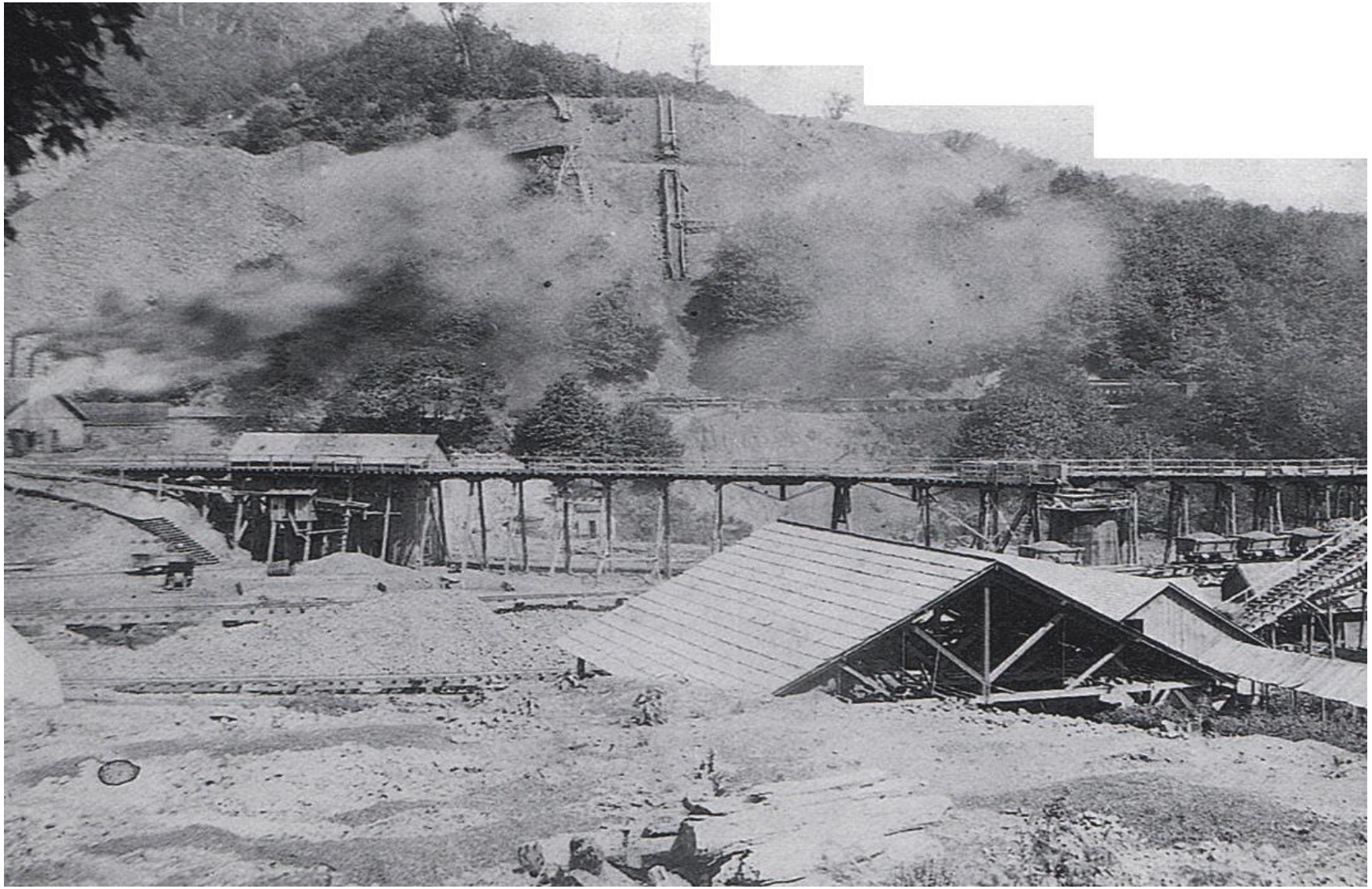


Figure 8. "Surface diggings high on the hillside provide the ore for the Cranberry Furnace c. 1885. Ore buggies can be seen at the base of the trestle-work behind the furnace on the right. Avery County Historical Society Museum Collection."[30]

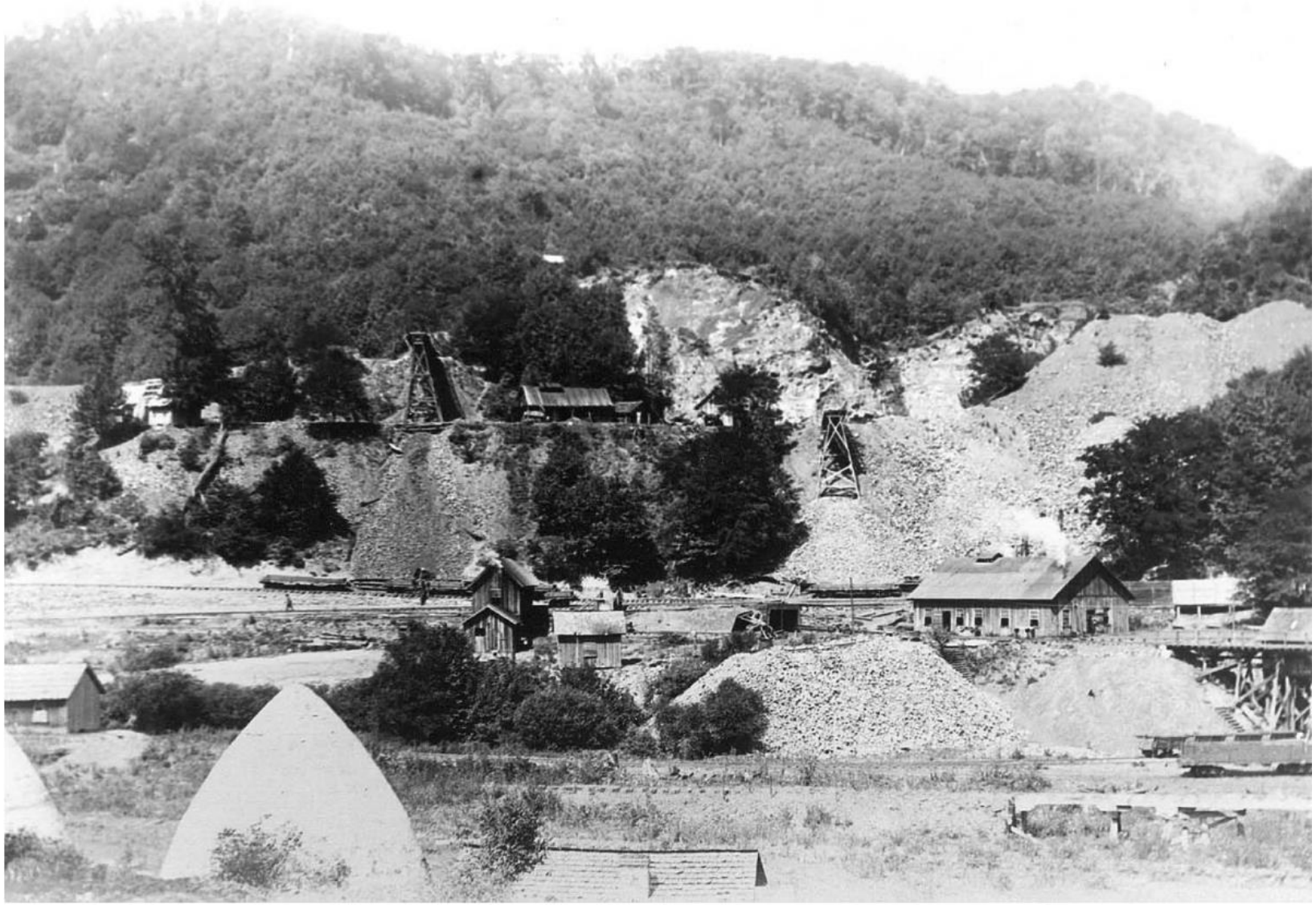


Figure 9. “While most of the mining at Cranberry in the late-1880s is still done at surface diggings, some mining is being done in the main tunnel. The entrance to the tunnel is just to the left of the building at the lower right, under the ET&WNC mainline. Burr Harrison Collection, Archives of Appalachia, East Tennessee State University.” Chris Ford dates this photo to “circa 1900”.[31]

1884 – 1892. “Cranberry, North Carolina,” by John R. Waite.

“The old Cranberry forge was abandoned. The company erected and ‘blew in’ a small blast furnace on the east bank of Cranberry Creek, early in 1884. When it was first constructed, it was an ‘old style’ cold-blast charcoal furnace. There was a market for cold blast charcoal iron because some industries believed such iron was superior due to the lower temperature used in its manufacture. Since charcoal could not support a heavy column of material in the furnace, charcoal furnaces were much smaller than coke-fired furnaces. The smaller capacity of the furnace resulted in higher costs, especially for labor costs.

The heart of the furnace operation was the 50-foot-high stack. The lower part of the furnace was the crucible or hearth; a reservoir for the molten iron. The liquid iron was drained out of the furnace through the iron notch, or tap hole, located a few inches above the bottom of the stack. A Little higher on the stack was the slag notch, also called the monkey, for draining off the slag.

The tuyeres surrounded the top of the hearth at regular intervals. They projected several inches into the stack and were protected from melting by water-cooled copper jackets. A bustle pipe surrounded the furnace and carried the air to the tuyeres.

The bosh was the sloping chamber above the heath. The base of the bosh on the Cranberry furnace was 10’ 2” across. The hottest part of the furnace, where the melting occurred, was at the top of the bosh. The inside of the furnace was fire brick; possibly with a water circulating system to keep the brick relatively cool.

Exterior columns supported a mantle around the bosh that carried the weight of the furnace stack. The stack extended from the top of the bosh to the throat of the furnace.

How the furnace was charged in the early years is not known; but in 1889, a new charging apparatus was installed. This new system was conventional for the era. It included a bell; a conical apparatus that could be raised or lowered to evenly distribute the materials, as they were dropped into the furnace. It also acted as a seal for the top of the furnace.

The raw materials were hoisted from the stock house, to the top of the furnace, on an inclined plane. Inside the small bridge house on top of the stack, workers transferred the materials to the furnace in small tramcars. In the early 1890s, to make the furnace operate more efficiently, they changed to wheelbarrows for the transfer.

In the early years, ore and limestone were hauled in gondolas and were hand shoveled from the railroad car to bins in the stock house. Later a long trestle was constructed and either hoppers or side-dump gondolas were used.

The furnace had a capacity of 14 to 15 tons of iron per day. The iron ore for the furnace came directly from the mine. The limestone was brought in by rail, from the company’s quarry at Watauga Point. The blast was generated by a waterwheel-powered air-pump, in a building just east of the furnace. The fuel for the furnace was charcoal produced on-site or purchased from local suppliers. A charging scale gave the company accurate records of the amount of materials required for each ton of iron…

The charcoal needed for iron-making was made by burning chestnut wood in ovens. The operation started with a large round pit 10 to 20 feet across and about 18 inches deep. Workers stacked split pieces of wood on end, short pieces first, then ever longer ones, until there was a large tepee-shaped woodpile in the pit. The stack was covered with mud, except for two small openings: one near the top to let out the smoke, and one on the bottom for firing. Once the wood was burning these openings would also be covered, allowing the wood to bum very slowly, creating charcoal.

Once the fire had been extinguished, the charcoal would be loaded into wagons using baskets. These baskets were woven from splits of hickory or white oak and were about six feet long and three feet wide. They had handles woven on each end, and it took two workers to carry them. They were made so that one end was deeper than the other, to facilitate pouring the charcoal out.

There was a row of charcoal ovens on the floor of the valley, just south of the furnace. A second row of ovens was added later. Many area residents had such pits on their own land and sold charcoal to the company. They hauled the charcoal to Cranberry in wagons. A short trestle just off the road allowed the colliers to dump the charcoal into tramcars. The cars were then rolled along a covered track to a long, narrow storage shed near the furnace.

Iron-making was an around-the-clock business. Since starting up the furnace was a major job, it usually ran 24 hours a day and was shut down only for lack of business or major repairs. Once the blast was started, steady work was required to load the stack and draw off the molten iron.

Every four to six hours, the liquid iron was drawn from the furnace through the tap hole. It ran to the cast house next to the furnace. The floor of the cast house was a bed of sand. The molten iron traveled down a main runner in the sand, overflowed into side runners called sows, then finally progressed to smaller depressions known as pigs. The solidified iron from each pig was a bar, also called a pig, about three feet long, three inches thick, and weighing about 150 pounds. After cooling, the pigs were hauled off on small tramcars and weighed. They were then dropped over a piece of iron and broken near the center. The fracture showed the grade of the iron. The pigs were then loaded on railcars for shipment.

When the furnace was operating properly, most of the iron produced was Number 1 and Number 2 pig iron with low sulphur and phosphorus content. At other times it produced less desirable grey forge, white, and mottled irons.

Slag, which formed from impurities in the ore chemically combining with the limestone flux, floated on top of the molten iron in the furnace. Periodically it was drained off, allowed to cool, and hauled away to the slag heap.

The operations of the mine and furnace required a large number of workers, and there was an occupational hierarchy. There was an ironmaster, who was in charge of the furnace; a founder, whose job was to make sure the furnace was running at peak efficiency; keepers, who were the founder's assistants; fillers, who worked in the bridge house keeping the furnace charged; guttermen, who prepared the sand bed in the cast house; colliers, who prepared the charcoal; woodcutters, who supplied the wood for the charcoal; teamsters, who drove the wagons; and assorted general laborers.

The mines and furnace failed to meet the financial expectations of the company. In the late 1880s, the mines sat idle for long periods of time and the furnace was periodically shut down. Company records indicate that it consistently cost more to produce iron than the price the company was receiving for the iron…

The management of CI&C tried to reduce costs and increase productivity. The furnace was converted to hot blast sometime before 1890. An oven supplied heat for the air blast, generated by the waterwheel-powered blowing machine, was routed through an oven to heat the air to about 800^{o} thus increasing the efficiency of the furnace. This oven was essentially operated at no cost because the fuel burned was waste gas taken from the top of the furnace stack. The waterwheel powered blower was eventually replaced by a steam-driven air compressor. This compressor had been used in the mine and was moved to the furnace. It was also fueled by the

furnace's waste gases. In the early years these waste gases had simply been vented to the outside, but when the furnace was converted to hot blast, the equipment was redesigned for economy and efficiency.

Charcoal was an expensive fuel, so in 1889 the company experimented with coke from Virginia's Pocahontas coal field."[32]

24 September 1885. The Johnson City Comet.

"The Cranberry Iron Works want one hundred and fifty hands to mine ore. The company cannot supply the demand although a train load is shipped every day. The demand is much heavier than ever before, and all this too under a Democratic administration."

28 January 1886. The Johnson City Comet.

"Mr. C.H. Nimson, general manager of the Cranberry Iron Works and Supt. of the E.T.&W.N.C. R.R. was in the city Tuesday. He wants 200 hands at Cranberry, but none but steady, sober men need apply."

25 February 1886. "The Great Cranberry Iron-Ore Quarry. By H.E.C., in The Iron Age. February 25, 1886.

It is hardly a proper term to call the present workings on the large deposit of magnetic iron ore at Cranberry, North Carolina, a mine. While in the past two tunnels were driven, as much for proving the quantity of ore as for any other purpose, yet the present workings are on a large open cut, and the ore is quarried out like so much marble or granite – in fact, more like the rough work in a railroad cut. The Cranberry magnetic ore is one of the most noted bodies of that ore. It was known for many years before there was any possibility of reaching it except by the roughest of wagon roads. The original forge was erected before 1812, and the first anvil-block and hammer were packed over the mountain from Virginia on horseback. In excavating for the last forge the foundation timbers of this old anvil-block were dug out, 5 feet under ground, perfectly sound. The iron made was famous throughout the South, and brought a higher price than any from the adjoining counties of Carter and Johnson, in Tennessee, which irons were made from limonite, except at Hampton, and had a high reputation.

The belt of ore commences, as far as at present explored, in the northeast end of Mitchell county, and extends in a general direction north 75° east for about 15 miles into Carter county, Tennessee. Like all the veins of the Allegheny mountains it is lenticular, having large bodies of ore connected by a comparatively narrow vein. These large bodies vary in their distance apart from ½ to 2 miles; the vein between is usually 4 to 5 feet thick. The ore at Cranberry outcrops on the west side of a small mountain in a great mass. On the east side at the foot of a high mountain an opening was made which developed the ore at a thickness of four feet. No exploration has been made any farther up the mountain. The body of ore is frequently capped and intermingled with handsomely crystallized hornblende and epidote. Pyroxene and calcite are also abundant in the vein, and sometimes a few crystals of quartz occur. No apatite has ever been found, and no phosphorus at all, or only a bare trace. It belongs to the self-fluxing magnetites, and resembles very much the ore from Chateaugay, New York, having probably less silica than that ore. It is,

therefore, as is that ore, very nearly or quite the counterpart of the famous Dannemora ore of Sweden. I give below a number of analyses of the Cranberry ore:

Magnetic oxide of iron	94.37	91.45	85.59	80.77	91.89
Oxide of manganese	0.26	0.06	0.24	1.42	0.32
Alumina	0.42	0.77	.11	0.52	1.03
Lime	0.43	1.01	0.72		1.06
Magnesia	0.36	0.53	0.33		0.23
Water		0.41	1.53		1.15
Silica, pyroxene	4.16	5.74	11.48	9.08	4.02
Sulphur					0.25
Phosphoric acid					trace
Metallic iron	68.34	66.22	61.98	59.49	65.58

These are undoubtedly choice specimens, as the run of the mine will give more lime, but in the deep workings as selected for shipment the ore is much improved in quality over that just obtained.

This property was bought in 1867 from Colonel J.C. Hardin and others for $40,000, General R.F. Hope [Hoke], of North Carolina, acting for the purchasers. General Hope [Hoke] immediately erected a new forge and made a large quantity of hammered bar, which he took North to show the quality of the iron. Some of this was made into steel, and proved to be of the best quality. Finally the property was sold to General A. Pardee and others, together with the charter and franchises of the East Tennessee, Virginia, and North Carolina Railroad. This road was chartered in 1866 and 16 miles graded, of which five were laid with iron rails; it was then built with a 5-foot gauge. Defaulting in the interest on the bonds loaned by the State it was sold to General Jackson, Colonel J.C. Hardin, and others for $25,000, and later sold with the mine to General Pardee and associates. The total price paid for mine and road is said to have been $150,000. These gentlemen decided to make it a narrow gauge, and, the charter having been so amended, they let it out by contract, and it was completed to Cranberry, 35 miles, in June, 1882, at a cost of about $800,000. This road connects with the East Tennessee, Virginia, and Georgia Railroad at Johnson City, 25 miles south of Bristol, at which place are ample tracks and platforms for transferring ore.

Work was commenced on the Cranberry ore by driving in a tunnel at nearly right angles to the vein and about 75 feet below its nearest outcrop on the east slope of the ridge. This tunnel was driven in 325 feet, of which 50 feet were in the ore. A year later a tunnel was driven in directly on the northeast end of the outcrop where it comes out at the butt of the hill. This was in ore from the start, and is still in use. Tunnel No. l is not now in use, the greater part of the work being mere quarrying in the open air. This work was commenced on the east side of the outcrop, and is being pushed south across the vein. The south face of this quarry is about 150 feet long, and the highest wall of solid ore is 50 feet and the lowest about 25 feet. The ore body is here estimated to be fully 300 feet thick. In the main or No. 1 tunnel a diamond drill was run in 150 feet, and was all that distance in ore and did not go through. Up to January 1st the ore, by contract, cost the company on the cars 60 cents per ton, and it was sold, delivered on the cars of the East Tennessee, Virginia, and Georgia Railroad at Johnson City, at $2.50 per ton. It undoubtedly does not now cost so much as 60 cents. Mr. Nimson, formerly of Allentown, Pa., is

general manager of the whole business, and Mr. Al. Nimson is superintendent of the mines and furnaces.

The furnace at Cranberry uses charcoal, partly made in pits and partly in conical kilns, and is run by water-power. It is calculated to average 7 tons and has made as high as 10 tons and as low as 3 tons per day. The make varies with the water supply. The pig is of the best character. When first ascertaining its quality large quantities of this ore were sent to Allentown and tested alone and mixed with limonite in the furnaces of the Messrs. Pardee. It worked well in either case. By contract 75 tons per day are now sent to the Crozer Steel and Iron Company, at Roanoke, Virginia. It is used there mixed with limonite. In first using it at Cranberry the usual quantity of lime was used and much trouble experienced. It is now used without any other lime than the calcite it contains in itself. The company owns at Cranberry about 4,000 acres of land, many houses, and a well-built Northern-style hotel at Johnson City. It intends to build furnaces as soon as good coke can be obtained at cheap rates. The total investment is said to be about $1,400,000. In this region is the only great body of steel-making ore in the South, and, as the supply is very large, it is destined to prove an important item in the future industries of the Southern States."[33]

8 April 1886. Herald and Tribune.

"Large quantities of the Cranberry iron ore are now being shipped to Rockwood, to be smelted there and then to be tested at the Bessemer plants in Pittsburg to ascertain their steel making properties. The smelting will probably commence next week."

29 April 1886. The Johnson City Comet.

"Cranberry Iron. The first Bessemer steel ever converted in the South was made in Chattanooga on the 20th inst., by the South-Tredegar Iron-works.

An experimental cast of two gross tons proved excellent steel on rolls and under all tests applied. The material used was pig-iron from Cranberry ores, North Carolina, and shows that ore to be excellent steel material. The plant has a capacity of eighty-five tons per day. The success of this experiment has cause much gratification among Southern iron makers."[34]

13 May 1886. The Johnson City Comet.

"A Cannon Ball Train on the E.T.&W.N.C. R.R. – The Gigantic Wonder of the Age. A Bird's Eye View of Cranberry – The Richest Magnetic Iron Ore in the World – The Only Steel Ore in the South. The Cranberry Hotel, A Palace Among the Mountains.

In compliance with an invitation the from Col. C.H. Nimpson, Superintendent of the Cranberry Coal and Iron Company, and the E.T.&W.N.C. R.R. Co., the following gentlemen from this place boarded a special train last Saturday morning for Cranberry: Col. E.C. Reeves, H.H. Carr, Esq., J.E. Crandall, W.A. Dickinson, C.K. Lide, John W. Hunter, E.S. Wolfe, Ike Harr, Esq., J.C. Hardin, Dr. E.S. Miller, Jr., J.W. Truslow, W.S. Mitchell, J. Drum, of Beatrice, Neb. and Ye Local.

A trial trip was run to test the new two hour and a half schedule that takes effect and proved entirely satisfactory. The train left here at 7:20 a.m. and made the run to Elizabethton, a distance of ten miles, in 19 minutes, including one stop. At this point we were reinforced by the

following gentlemen: Maj. H.M. Folsom, Dr. J.M. Cameron, Dr. E.E. Hunter, C.C. Collins, C.P. Toncray, John P. Smith, R.A. Smith, J.C. Smith, J.M. Simerly, J.H. Alexander, H.C. Boyd, W.M. Cameron, W.R. Fitzsimmons and H.R. Lutz, of Rogersville. Leaving there we soon entered the 'gorge' and were whirled over bridges, thro' tunnels and along deep ravines until we reached Pardee Point, where the train stopped to rest, as it were, and allow us to better view and admire the grandeur of the scenery. This is considered the wildest part of the 'gorge' and more than justifies the reputation this road has gained as being the

Gigantic Wonder of the Age.

Nature seems to have brought into action all its reserved powers and concentrated them on this one point. To stand there and look down, hundreds of feet below, at the pure limpid waters of the Doe River as it surges on over its rocky bed through narrow defiles and beautiful valleys in its mad rush to the sea, and then behold the mountains of solid rock that rise thousands of feet above on all sides, one cannot fail to recognize the presence of a Supreme Being and realize their own insignificance. This road is said to be the grandest piece of engineering in the world, and will ever stand as a monument to the engineering skill of Col. T.E. Matson. Leaving there we continued to ascend the mountain, 158 feet to the mile in some places.

Arriving at Cranberry we were soon climbing a mountain of solid iron, under the leadership of Col. Nimpson, from the summit of which we could look down on the miners at work and hear the clatter of the steam drills, From this point we also had a

Bird's Eye View of Cranberry,

the small but neat little mining village in the valley 500 feet below us, with its furnace in full blast. The Cranberry of to-day is not what it was a few short months ago, the change it has undergone is so remarkable one who has not visited it lately would hardly know the place. Formerly it was considered dangerous to be caught out there after dark. There was so much drinking, fighting and killing that no peaceable man could stay there, and it deserved the reputation it bore of being a regular 'hell-hole.' To-day, a more peaceable, quiet set of people would be hard to find even in incorporated towns. The change has been so complete since January 1st that of the 300 to 500 names on the pay roll now only about 20 of them are old employees.

A Sunday School has been organized, and once a month, Rev. W.G. Mallonee holds church services. Col. Nimson has very generously allowed them the use of his store room until he can have a room fitted up for a church. We had the pleasure of attending their service last Sunday night and must say we were very favorably impressed with the general intelligent appearance of the people.

Before leaving the mines Col. Nimson gave us an idea of the size of the deposit and the quality of ore. He said that in his forty years experience in mining all kinds of iron ore this was the best he had ever handled. It is not only the

Richest Magnetic Ore

in the world but being free from phosphorus and sulphur it is also the best steel ore. There are no Mines in America that can begin to compare with this one either in quality or quanity of ore. New Jersey is the largest magnetic ore State in the Union, with an annual out-put of 500,000, tons. It would take all of its mines 20 years to exhaust the supply of 'ore in sight' at the Cranberry mine. While the recent successful test of this ore at Chattanooga was the first steel

made in the South it is not the first time this ore has been converted into steel. When the mine was first opened the company shipped several thousand tons North and had it tested as a steel ore. It proved entirely satisfactory.

When we had visited all the other points of interest we boarded the train and were taken back to the Cranberry Hotel. It might be very appropriately termed

A Palace among the Mountains.

Our walk had prepared us with a good appetite but the caterer was equal to the emergency and all enjoyed the dinner served in the elegant style peculiar to this hotel. This new to beautiful hotel is located at the top of the mountains, 3200 feet above is level of the sea, is elegantly furnished throughout, has all the modern conveniences of a city hotel and is presided over by Mr. Wallace Hahn, the Auditor of the E.T.& W.N.C. R.R…

When the applause had died away Col. Nimson responded in his easy, graceful style as follows…

By tunneling, shafting, boring and surface mining the Cranberry iron ore deposit is now developed 400 feet wide, 280 feet high and 1500 feet long. By experience of mining 4000 tons, we find that every 7 cubic feet in place will make one ton of iron, showing the deposit to contain over 20 million tons above the surface of the valley, through which the indications show that it runs very deep below the lowest level it has been opened. Surface indications and croppings also show the ore to continue thro' the company's property for over 5000 feet beyond the present workings where the ore has again been developed by Gen. Imboden.

To mine and transport the ore developed now, to Johnson City will cost in labor over $40,000,000. Two-third of which, at least, will, through the necessity of this labor, flow as naturally into the pockets of the farmers, merchants and mechanics of E.T.&W.N.C. as water flows down hill. While on the other hand it will require the most careful nursing and jealous guarding of this interest, on the part of the management, to make it ordinarily remunerative to the men who have made the venture to develop it, and for this reason, gentlemen, I frankly court your friendship, encouragement and aid in every way, in my efforts to manage the affairs of these companies to the interest of the stockholders and the communities you represent…"

10 June 1886. The Asheville Citizen.

"Week before last at Cranberry, Frederick Austin, who was conducting a car loaded with lumber along the inclined tramway, was knocked down and injured internally by the car which got away from him and became unmanageable. Austin died last Sunday week, we are informed."

28 October 1886. The Johnson City Comet.

"100 Hands Wanted. The Cranberry Coal and Iron Co want 50 or 100 good, steady men to work in the mines. None but steady, sober men need apply.

C.H. Nimson, Supt.
Cranberry, N.C.
June 30, 1886."

January 1887. The Bulletin of the American Iron and Steel Association.

"Finding a Market for Cranberry Ores. The value of the Cranberry deposit of iron ore in Western North Carolina and Eastern Tennessee is well known to our readers, it having frequently been described. This extensive iron ore field is found in a great vein running east and west through Mitchell county in North Carolina and Carter county communication by General J.T. Wilder to the Iron Age gives the following particulars concerning the present development of this field and its future prospects. He says:

Now that Bessemer steel is taking the place of wrought iron so extensively, Southern ironmakers have naturally been anxious to find ores suitable for the manufacture of Bessemer pig. Thus far only one extensive bed of ores low enough in phosphorus suitable for this purpose has been found in the South. This is known as the 'Cranberry ore.'

The Cranberry Iron Company, a Philadelphia corporation, has opened the eastern end of this great ore bed, and has in the last five years exploited some 1,500 feet of the vein, and has proved the vein to be fully 300 feet wide between the walls, and has now in sight some 40,000,000 tons of ore. This company has been instrumental in building a narrow-gauge railroad from its mines (34 miles) to Johnson City, on the East Tennessee Railroad, and already has more orders for ore than it can fill until its mines are more fully opened. These orders are from the furnaces at Roanoke, Va., Newport, Ky., and Chattanooga, where the Roane Iron Company is just completing a fine Bessemer plant to produce ingots for its rail mill. The South Tredegar Nail Works, at Chattanooga, has the last summer put in operation a small Bessemer converter to make steel from these ores for their nail plate. The steel made is superb, and no ore makes better pig for Bessemer steel than these Cranberry ores. Already have the furnacemen of Chattanooga and Birmingham secured sections of these ores…"[35]

20 April 1887. Biennial Report of the Bureau of Agriculture, Statistics, and Mines of the State of Tennessee.

"The real Birmingham of the United States, in embryo, is Johnson City, situated in Washington County, at the junction of the Cranberry Narrow Gauge with the East Tennessee, Virginia & Georgia Railroad, or will be within thirty miles of this point. This prediction is made with the entry of two exceptions: First, that an abundant supply of water for all purposes can be obtained at reasonable cost, and, second, that cheap railroad transportation can be obtained to and from the coal mines of Southeastern Kentucky and Southwestern Virginia, and also to the numerous iron ore and zinc ore banks, granite and limestone quarries which lie in close proximity to this city. Other conditions, such as climate, soil, timber, etc., are most favorable…

Johnson City has a large tannery and also a large machine shop, and other industrial establishments which give great promise, all of which are owned and operated by very enterprising men. Should furnaces and the Bessemer steel plant promised be located here, it will give an impetus that will carry her into the twenty thousands at an early day."[36]

"A Chattanooga Bessemer Steel Plant, April 20th [1887], the material used for the purpose being Cranberry iron, smelted from ores mined in Mitchell County, North Carolina. The product was in all respects perfectly satisfactory. It sets at rest the question 'Has the South a Bessemer steel ore in large quantity?' It makes Chattanooga the pioneer Southern steel maker of Southern materials, and foreshadows an indefinite number of enterprises to spring up there and at other Southern points that have been held in abeyance by the fact that our iron so far has lacked

this, the most valuable and rapidly becoming the indispensible form, Bessemer steel. Much capital will come among us now that would not come before this experiment proved successful. I have full faith that it will hasten the reopening of the great Roane rail mill, with its 600 operatives, and a product worth in its yard not less than $3,000,000 a year.

It has long been known to a few that a like experiment with this iron made by a Philadelphia establishment was successful. Chemists have always rated it as a Bessemer ore. But the average iron master of Pennsylvania and Ohio said to all these showings: 'It is of first importance to the symmetrical development of the Southern iron trade, that it have a reliable body of Bessemer materials. If you have that, the way to convince the world of the fact, and at the same moment give your section a big boom, is to show your faith by building an experimental steel plant and fully testing the Cranberry as a Bessemer iron.' That has finally been done, and the doing at once demonstrates that Chattanooga can compete with and beat all comers in her home market in steel nails, railroad bars and a score of other articles now made of steel."[37]

Spring 1887. "Wm. M. Meredith V. Cranberry Coal and Iron Company…

Smith, C.J. The plaintiff, an employee of the defendant company, at per diem wages, while engaged in transporting wood, to be converted into coal, from the forest to the woodyard over a tramway constructed for that purpose, was struck with a stick of wood, protruding from a loaded car, and thrown from the platform on which he was standing, and suffered the injury for which compensation is demanded in the present action. The complaint alleges, that this was brought about by the cording or packing of the wood too near the tramway, and on either side of it, as directed by one Allen Nimson, a manager and middle man, representing the company in the operation of this department of the work, by reason of which proximity, a loose stick, slipping from the load on a passing car, came in contact with that packed, and in its rebound knocked the plaintiff off, and caused the injuries complained of…

The facts disclosed in the testimony, heard at the trial, so far as they are necessary to elucidate the matter on which the determination of the defendant's appeal rests, are, in substance, the following:

The wood was cut and brought from the forest, a mile distant from the place of deposit in the yard, on flat cars, each carrying a cord, passing over a tram or railway, on an inclined plane, and descending by force of gravitation, the speed being controlled by breaks on each. At the time of the accident, the train consisted of two loaded cars, upon the rear platform of the foremost of which, the plaintiff was standing. The train was moving with unusual rapidity, and several sticks of the wood on a car were jostled and began to slide, to prevent which, the plaintiff, being called on to do so by one Bass, a fellow-servant, at the lower end of the nearest car, stepped on the adjoining platform of that car, and seized a loose stick, with the intention of replacing it, and in doing so, the stick came in contact with the stacked wood, and the other end struck the plaintiff with great violence and threw him to the ground. While prostrated, he sustained the injury mentioned. The placing and stacking the wood so near the tramway was done by the express order of said Nimson, to whose charge and management the business was confided by the defendant, and his co-laborers in the work of transportation, as was the loading of the cars and accompanying them to the place of unloading, but it does not appear that any instructions were given as to the manner of putting up the wood, or supervision exercised over the work as it progressed.

It was no uncommon thing, as the plaintiff himself testifies, for the wood on the car to be so disturbed by jarring of the car in motion, and if not going too fast, it was not hazardous to arrest it, and retain it in place, in the manner attempted in this case. It was, if the car was going rapidly. A witness for the defendant, John Ellis, who graded the track, and had been connected with the road for 33 years, after describing the declivity of it, and its passing between the stacks on either side of the yard, testified to having cautioned the plaintiff, perhaps as many as twenty times, about running too fast, and told him that some of the men would be killed if they came down so rapidly, and that sometimes, when himself riding on the cars, he would enjoin it on the employees to run slowly.

They were expected to make eight trips a day, and lacked one of completing the number at the hour 3 P. M., on Saturday, when the plaintiff was hurt.

Allen Nimson, examined for the defendant, also testified to his warning repeatedly when riding on the cars, and when passing them in motion cautioned the hands in charge, the plaintiff among them, against fast running, and that the plaintiff had been in this employment from one and a half to two years.

There was a general concurrence of opinion among the witnesses, and especially among those of skill and experience, in the defendant's service, who were introduced by it, that cars could, when so loaded, be run with safety, if run slowly, and little, if any, hazard would be incurred in restoring slipping pieces to their proper place by hand; but it would be otherwise, if the cars were moving at a rapid rate. Whether the cars were moving at an increased speed on this occasion, the evidence was somewhat in conflict, but none that they moved slowly…"[38] See Appendix D for the complete text of this document.

25 October 1887. "The Great Mineral Region of North Carolina. C.H. Henderson in The Philadelphia Ledger, October 25…

Leaving the trough of the Great Valley at Johnson City, Tenn., a short narrow-gauge railroad runs in a southeasterly direction, just over the border line, into North Carolina. For several miles the railroad traverses the limestone through such suggestive localities as Happy Valley until it reaches the wild gorge of the Doe river. Few Colorado canons afford finer geologic sections than one finds here. Thousands of feet of rock are open to view, strata lying upon strata, with their unturned edges exposed in regular order like the leaves of a gigantic volume in which is recorded the history of the earth. When these formations have been crossed the road passes on to the older crystalline rocks, and so continues until its terminus is reached at Cranberry.

Here the Cranberry Iron and Coal Company has built up a thriving, active community where five years ago there was nothing but a few mountaineers' cabins. It has expended about $1,400,000 in building the narrow-gauge railroad from Johnson City, in opening the mines, in constructing furnaces, ovens, and other necessary adjuncts, and in creating a well-equipped town in the midst of a mountain wilderness.

The iron mines are located immediately in the town, and are, of course, the life of the entire enterprise. Formerly all of the workings were underground, the ore being removed through a tunnel. Now, however, nearly all the mining is on the surface, and reduces itself to simple open-air quarrying. The ore is chiefly the magnetic oxide of iron. It varies considerably, both in its appearance and physical properties. In some places it is very fine grained and difficult to

break into convenient pieces for handling. In others, again, it is so coarsely crystallized that it breaks almost too readily, and forms a coarse iron sand…

Three large benches have been excavated and the mountain side made to assume the appearance of a very large quarry. Day and night the work of demolition goes on, the mine eating further and further into the mountain at the rate of 225 tons of ore each twenty-four hours. Day after day the long trains of loaded cars pass down the gorge to feed the ever-hungry iron furnaces. The ore is sold in lots of fifty and a hundred thousand tons, most of it being shipped to the furnaces of the Roane Iron Company, at Rockwood, Tenn., and of the Shenandoah Iron Company, at Milnes, Va. It is said to average about 50 per cent. metallic iron, its chief value being in its purity. Those troubles of the ironmaster's life, sulphur and phosphorus, are almost absent. The ore is, in consequence, admirably adapted for the production of Bessemer steel, or for other purposes requiring great purity in the raw material.

The town of Cranberry is very prettily located among its iron-sinewed hills. A small charcoal furnace stands in the centre of the town. It consumes about twenty-five tons of ore daily, producing from ten to eleven tons of pig metal. The ore for this use is first roasted, to make it more friable, and is then broken in a stamp mill to the size of a goose egg. The furnace is about fifty feet high, and has a three-foot crucible. In appearance it differs from our own furnaces in having a vertical outline from the bosh to the tunnel head. It is operated by hot blast."[39]

1887. Ores of North Carolina, by W.C. Kerr and George B. Hanna.

"Iron Ores of Mitchell and Ashe… The developments at this mine at the close of 1886, are briefly given below from notes of the general superintendent, C.H. Nimson:

The deposit is penetrated by one tunnel for over 500 feet, and by another tunnel at right angles to the first (at a level 50 feet higher) for 700 feet; 50 feet still higher are open works. The floor of this working is ore, and receives the ore from a breast or stope 50 feet high, and 500 feet long. Above this, and immediately over it, are two more stopes or breasts, each 50 feet high, and 200 feet long. These three open cuts are all in ore; and above this third bench is 130 feet of ore to be stoped or turraced out. All these workings, in connection with the diamond drill work, places a deposit of ore in sight 1,700 feet long, 400 feet wide, and over 300 feet deep, down to a level 50 feet above the level of the valley. Below this point no tests have been made, but the floor of the lowest tunnel has the richest and most solid ore that the mine has yet furnished. The present capacity of output is 100,000 tons per annum. The ore is used in Virginia, Kentucky, Tennessee and Alabama, and the demand exceeds the supply."[40]

1887. "Mineral Resources of the United States, Calendar Year 1887."[41]

"The only development yet attempted on this line of ores is at Cranberry, Mitchell county, North Carolina. The face of the hill has been uncovered, showing a mass of very pure magnetic ore nearly 400 feet thick to a height of 300 feet. The mining is now simply quarrying in open cut. The output of the Cranberry iron ore mines in 1887 was 45,032 long tons."

5 January 1888. The Johnson City Comet.

"The Cranberry mines have shut down because at present, there is no demand for the ore. Thousands of tons are stocked on the yards at Johnson City, and which could be shipped any day

a market could be found. It is about time some protectionist crank was attributing the suspension to President Cleveland's message."

19 April 1888. The Johnson City Comet.

"Johnson City. The Gateway to the Mineral and Timber-Laden Alleghanies. In the Heart of the Magnetic Ore District… Iron Ore Fields… The East Tennessee and Western North Carolina Railroad extends from Johnson City to the famous Cranberry mines, which produce the best steel making ores in the South. A writer had this to say about the famous Cranberry mine:

'This mine now has a working capacity of 500 tons a day; it has six breasts of 50 feet high and a width of 286 feet, marked against the solid ore and, in addition, shows a solid cropping of 120, bringing the dimensions of the deposit to 400 feet wide, 300 feet high and 1700 feet long; the lowest working of which is 50 feet above the water level and where the river crosses the valley.

By mining over 100,000 tons I find it requires from 7 to 9 cubic feet to make a ton, which readily shows that upward of 20,000.000 tons of ore are not in sight. This ore is a Clear Bessemer Ore, a fact that has been demonstrated by the making of 20,000 tons in the furnace at Cranberry, N.C., 20,000 tons at Allenstown, Pa., and 50,000 at Rockwood, Tenn., the latter by the Roane Iron Company of Chattanooga, which has used the product in their Bessemer plant at that place with unparalleled success.'"

6 December 1888. The Johnson City Comet.

"The Cranberry Iron company, which has been running with a reduced force for several months past is advertising for one hundred and fifty hands to work in the mines. Large orders have been received for Cranberry ore from both northern and southern furnaces, and the prospects are that the mines will be run in full blast from now on. The only drawback is the scarcity of labor, and but for that Cranberry would show its old time activity. – Journal."

1889. On Horseback: a Tour in Virginia, North Carolina and Tennessee..., by Charles Dudley Warner.

"Cranberry Forge is the first wedge of civilization fairly driven into the northwest mountains of North Carolina. A narrow-gauge railway, starting from Johnson City, follows up the narrow gorge of the Doe River, and pushes into the heart of the iron mines at Cranberry, where there is a blast furnace; and where a big company store, rows of tenement houses, heaps of slag and refuse ore, interlacing tracks, raw embankments, denuded hillsides, and a blackened landscape are the signs of a great devastating American enterprise. The Cranberry iron is in great esteem, as it has the peculiar quality of the Swedish iron. There are remains of old furnaces lower down the stream, which we passed on our way. The present 'plant' is that of a Philadelphia company, whose enterprise has infused new life into all this region, made it accessible, and spoiled some pretty scenery."[42]

20 February 1890. The Johnson City Comet.

"Furnace Blasts. Last Monday dirt was broken on the first furnace to be built by the Carnegie Iron Company, and as soon as it gets well under way the second will be started. Mr.

Harry Hargreaves, of Birmingham, is the contractor and is rustling things with that energy peculiar to himself. He has the excavating for foundations about done. Eight side tracks are to be put down around the furnaces and a large force is now at work grading for them. Rock are now being placed for the foundation and masons are at work. The force is being increased as fast as circumstances will permit. Mr. Hargreaves says he will have the iron work ready in 60 days and by that time he expects to have 500 men at work. He has contracted for the erection of 68 houses for his men, who will camp in tents until they are built. Both furnaces will have a capacity of 125 tons of pig iron daily and that means a tonnage to a railroad company of 1,600 tons per day for 365 days in the year."

12 March 1890. The American Engineer.

"1 3½ x 3½ foot furnace charging scale, [purchased by the] Cranberry Iron & Coal Co., Tennessee."[43]

April 1890. The Railroad and Engineering Journal.[44]

"At the Philadelphia Testing-Machine Works of Riehle Brothers, the orders recently received include… charging scales for… the Cranberry Coal & Iron Company, Cranberry, Tenn."

12 April 1890. Engineering and Mining Journal.

"Mitchell County. It is reported that the Cranberry iron mines are about to pass into the hands of an English syndicate, who will build a town, erect furnaces and establish iron manufacturing plants."[45]

17 April 1890. The Western Sentinel (Winston-Salem, North Carolina).[46]

"Cranberry iron mines have been sold, it is said, to an English syndicate for $6,000,000. – Charlotte Democrat."

22 May 1890. The Johnson City Comet.

"Gen. Wilder Talks about Johnson City in Connection with Chattanooga. He Predicts an Era of Commercial Greatness for Both – He Says the Cranberry Mines are Unparalleled – The Finest Magnetic Steel Ore Produced from Them.
Chattanooga Times.)

Gen. Wilder, who has the construction of four blast furnaces under way at Johnson City, Tenn., was at the Hotel Stanton yesterday. The General has been closely identified with the commercial and iron industries of East Tennessee for the past twenty-five years. In a pleasant chat he spoke about the wonderful development now going on in Johnson City, and said that within the past year the plucky little town had experienced a building boom, and this consequently advanced real estate without the aid of attractive advertisements, or the magnetic glamor of an auctioneer's eloquence. The city has grown from the ground floor up, and there is

every element about the place to assure the disbeliever in new cities that it will become an industrial center of great importance.

Gen. Wilder said that the city was laid out to accommodate a population of 100,000 people, and his predictions were that this number would ultimately locate there. He is certain that if the prophecy comes true the city will have sufficient industrial enterprises of a stable character to provide for all who seek a home there.

Among other things he referred to was the marvelous vein of ore in the Cranberry district. He said that this vein is the finest magnetic steel making ore in the entire world. It is lower in phosphorous by one-third than any ore on the American continent, and therefore best adapted to the needs of producer of Bessemer steel rails. In referring to Andrew Carnegie's sweeping denunciation of Southern pig as a metal for producing Bessemer steel rails, the General said that Mr. Carnegie did not know anything about the great vein which ran twenty-eight miles along the Chilhowee Range from Johnson City or he would not have spoken as he did. He stated that this vein was 400 feet thick; that upon the surface around Johnson City there was more Bessemer ore than could be used in all the Southern furnaces in fifty years, no matter how many furnaces were built. He further remarked that the ore was placed under the most severe tests by the several analytic chemists connected with the Roane Iron Works at Rockwood, the Allentown Iron Works, Pennsylvania, the National Tube Work, McKeesport, Penn., and the Crescent Steel Works, Pittsburg, Penn.; all of the chemists pronounced the pig which is produced from the ore to be the best for the purpose of producing steel in the United States.

The Crescent Steel Works, operated by Miller, Metcalf & Parkins, is using the pig metal from the Cranberry mines for the production of silver steel which is the finest in the market.

The General went on to state that the building of furnaces at Johnson City will be of immense advantage to Chattanooga. One of the furnaces will be in operation early next January. He went on to say that Johnson City would supply Chattanooga with pig metal for its steel making. Some of the Northern manufacturers had made overtures to the Johnson City Company asking it to supply them with all the pig it could output. But, said the General, I refused them; Chattanooga is always prominent in my heart, and to help the progress of this city Johnson City will take a hand which will mutually help both.

The General said that had Chattanooga accepted his statements twenty-five years ago, she would have been a greater city than she is now. People thought his ideas chimerical and dreamy, but after developments proved that he was right, and have vindicated him. What were then thought hyperthetical conjectures are now demonstrated facts, and hundreds of people are enriched thereby.

Between this city and Johnson City there will be the best railroad facilities provided; now the two cities are connected by the main line on the East Tennessee, Virginia & Georgia Railroad. From Johnson City there are being constructed other railroads which will give the product of the city an outlet into the Eastern and Western markets. The general said that some of the most magnificent union depots will be built in the South.

Gen. Wilder thinks that Johnson City's close proximity to Pocahontas coal mines will be a great lever to help it on to commercial greatness."

6 June 1890. General Robert F. Hoke, Lee's Modest Warrior, by Daniel W. Barefoot.

General Robert "Hoke maintained ownership in the railroad and mining operations in the Cranberry area for several decades. In a letter to a Philadelphia businessman on June 6, 1890, he

extolled the virtues of some of his mountain holdings: "The Iron property that I and some of my friends own is situated about 20 miles from Cranberry. This is one of the purest and richest ores I have ever seen, and I believe the vein will yield large quantities of ore… If you desire to look into the property with a view to purchasing, I will arrange to meet you sometime this summer."[47]
2 August 1890. The Electrical World.

"Southern Notes… A New Telephone Line. – A telephone line from Linville, N.C. to Cranberry, in the same state, is being constructed, and the poles have already been placed.

Telegraphic Line Completed. – The telegraph line which was being constructed between Blowing Rock, N.C. and Boone, the county seat of Watauga, was completed on the 14th instant."[48]

14 August 1890. The Johnson City Comet.[49]

"… The rocks, the beautiful rocks, are piled up in pyramids as if placed there by the hand of man, instead of the hand of nature. We never fully realized the power and magnitude of God's works before. The scenery through this gorge is sublime, terrific and beautiful. It is a marvel that a road could be made around and through these mountains, and trains passing along over it daily. All visitors to our city make a run to Cranberry Mines.

We had thought our city and surroundings very picturesque, but since our trip through the world's wonder it looks very tame.

All along these mountain ranges the wild flowers are blooming in rich profusion. Here is the beautiful and sublime combined in one. The scenery grows wild and the wilder it grew the more we enjoyed it. We were lifted up, and out of self with rapturous pleasure and delight at exquisite and lovely panorama.

Mountain scenery is the grandest of all scenery. This is a bower of beauty a garden of Eden. The mines are too complicated to take it all in at one short visit, but we saw enough to give our sympathy for the poor miner. Think of them working all day under ground, excluded from the sunlight of heaven and the sweet songs of birds and the beauties of nature, in a cold damp pit…"

1890. "Cranberry, North Carolina," by John R. Waite.

"In 1890, ore washers and Wenstrom magnetic separators were installed under the trestles of the mine. This improved the quality of ore shipped from the mine and reduced the amount of small sized iron ore that was sent to the tailings piles. A Buchanan crusher and Yates fine crusher were added later to make the separators more efficient. The mine's ore yielded 63 to 66 percent iron in 1892."[50]

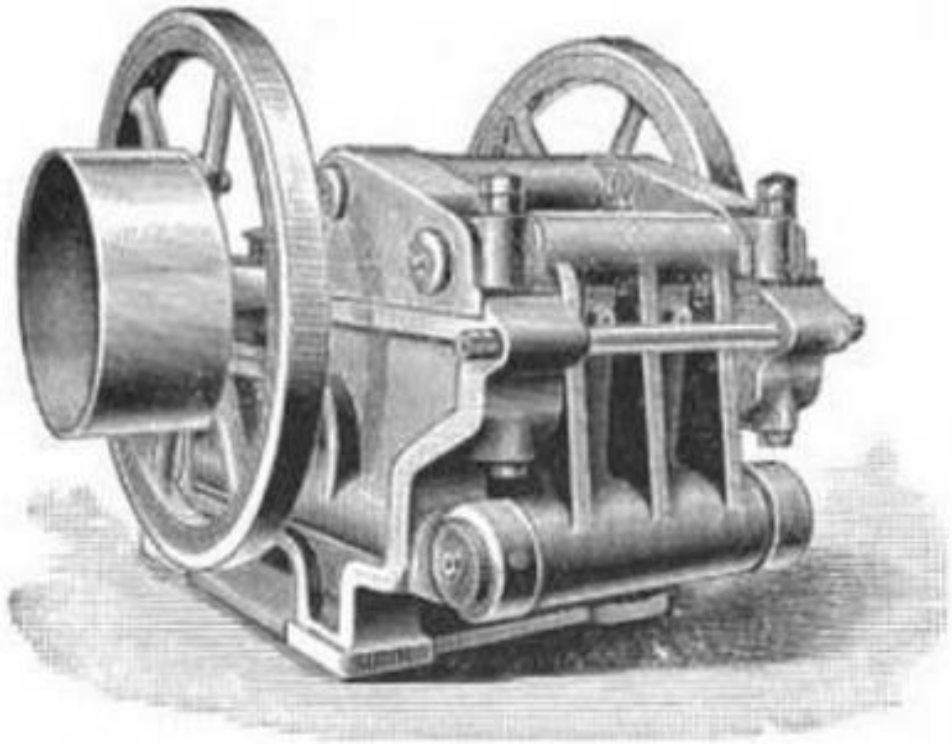


Figure 10. Example of a "Buchanan Ore Crusher"[51]

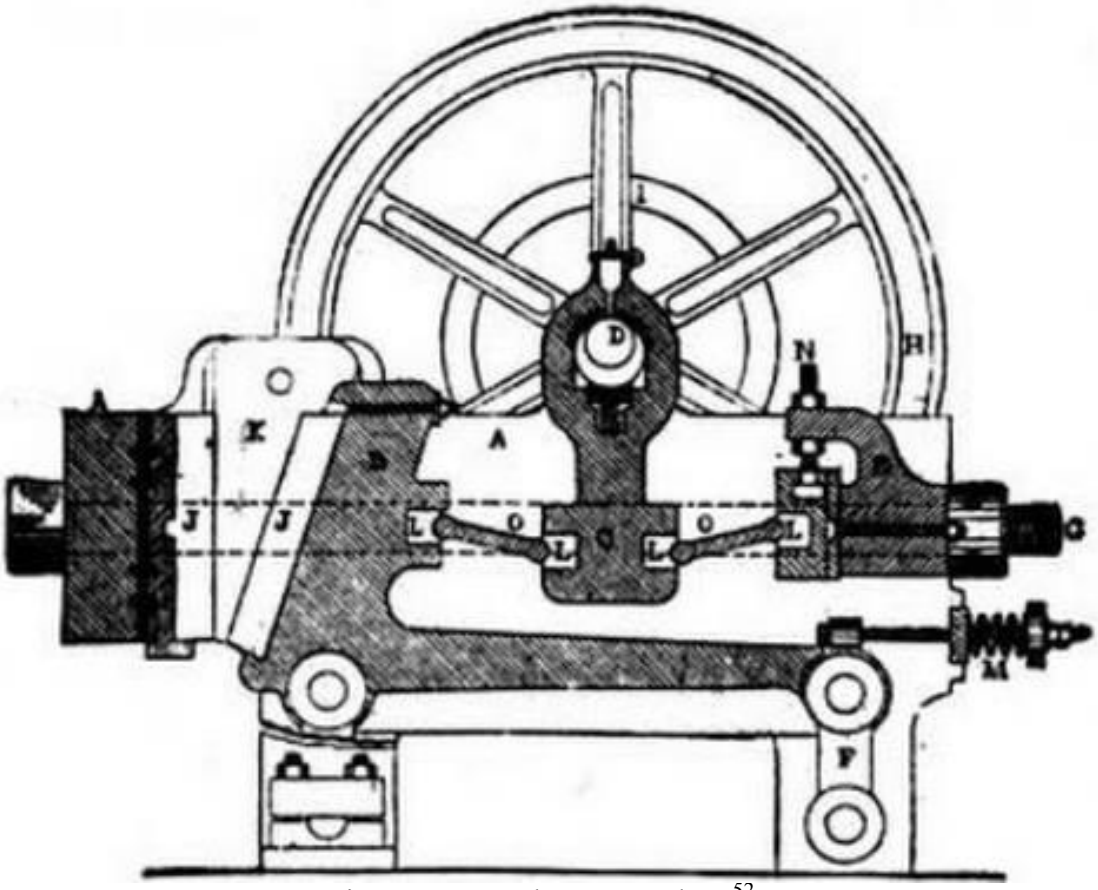


Figure 11. "Buchanan Crusher"[52]

September 1890. "Progress in Magnetic Concentration of Iron-Ore," by John Birkinbine.

"…A plant is also in operation, and about to be enlarged, at the Cranberry ore-mines, in North Carolina, using Wenström separators. At the present writing there are, in the United States, nine Wenström machines employed in separating iron-ore, and four that are used in steel-works upon the waste from converters, etc…"[53]

"Some Forms of Magnetic Separators, and Their Application to Different Ores," by H.C. McNeill, Assoc. R.S.M…

(1) The Wenström machine. – This is probably the simplest, and, for the particular purposes which it is intended to fulfil, the most efficient separator at present in use. Unlike most other designs, it is capable of treating ore of fairly large size, and it is not necessary that the stuff treated should be previously dried; its chief use is in such cases where the magnetite iron ore contains inclusions of rock, or where, as in open cast workings, portions of the containing walls of the ore body get mixed with the ore in blasting and like operations. As a general rule, it is found to be more economical to pass the whole of this material collected together over a Wenström machine, after the 'best' of a blast has been dealt with, than to attempt further hand selection in the quarry or under ground. In addition there are other uses to which this separator may be put, such as the treatment of cupola residues and foundry loam and sand; also the recovery of cast iron shot entangled in blast furnace slag, &c."

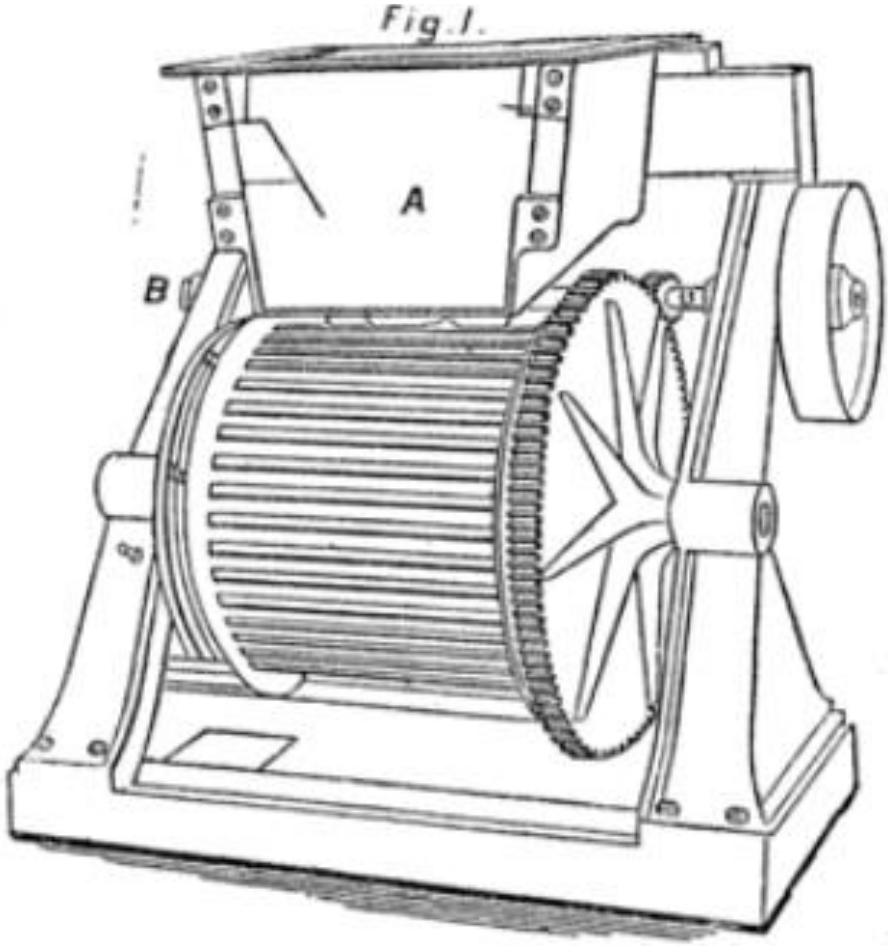
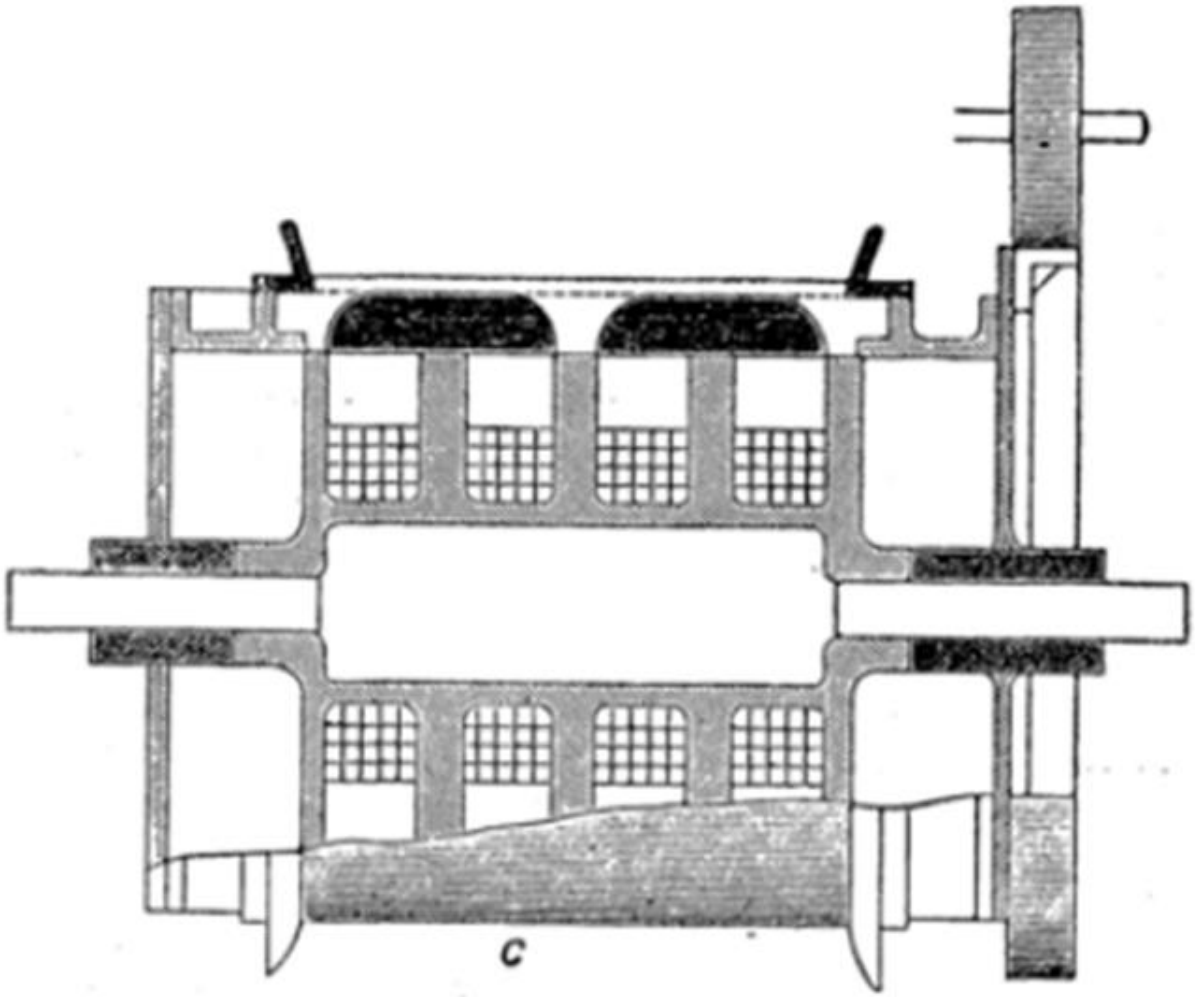


Figure 12. Example of a "Wenström Magnetic Separator"

Figure 12 “gives a general view of this machine. The material to be treated is fed through a hopper A, and on to a jigging tray, which receives its motion from a cam arrangement placed on the shaft B B. This tray is inclined, and at each recoil a line of ore is left on the drum. Figs, [13 and 14] show part sections of the drum in directions at right angles to one another. C is the armature barrel, consisting of a series of soft iron bars, each separated from the other by a bar of wood. D is a stationary field magnet, placed excentrically with regard to the armature barrel. Non-magnetic end plates, carefully fitted with ‘jointing,’ so as to be water-tight, bind up the whole into the form of a drum. The bars of soft iron are internally shaped, so that each successive bar becomes oppositely magnetised, a combination of greater power being thus exerted on a piece of ore large enough to bridge the distance between two adjacent bars.”



[Figure 13.]

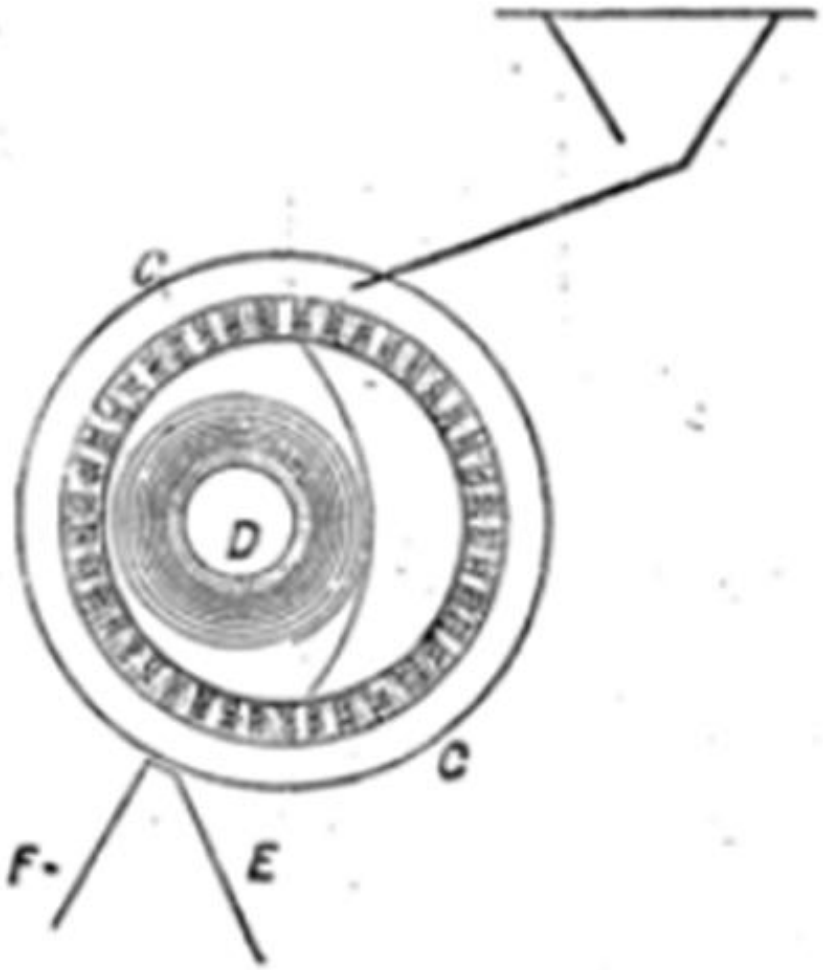


Figure 14.

"The magnetic portion of the ore adheres to and is carried round on the drum until beyond the influence of the magnetic field, when it drops away down a shoot at E, whilst the non-magnetic portion passes down in front of the drum into a shoot at F. A machine with a drum of 2ft, 2½ in, diameter and 2ft. length, revolving at thirty revolutions per minute, will treat about five tons of mixed material per hour. Such a machine is capable of dealing with ore of any size up to pieces that will pass through a Screen of 4in. mesh, and requires a current of 15 ampères, the tension at the dynamo terminals being 110 volts. Although the machine may be and is used on ore which is quite wet, the greatest efficiency is obtained when the material to be treated is dry, and in some cases, as at Dannemora, Sweden, care is taken to treat only that ore which is fairly dry, without incurring the expense of artificial drying; whilst in other instances – Grängesberg and Grangen – the ore is treated directly after being washed, and whilst quite wet. This separator requires but little care and attention when working, whilst the cost of maintenance is practically nil. Generally the most efficient plants are also the simplest. The process usually consists of either a rough preliminary sizing by means of revolving or flat screens, with or without washing, followed by treatment on the separator, or the uncleaned ore may be passed on to the magnetic machine direct, and subsequently screened into different market sizes…"[54] For additional information, see appendices E and F.

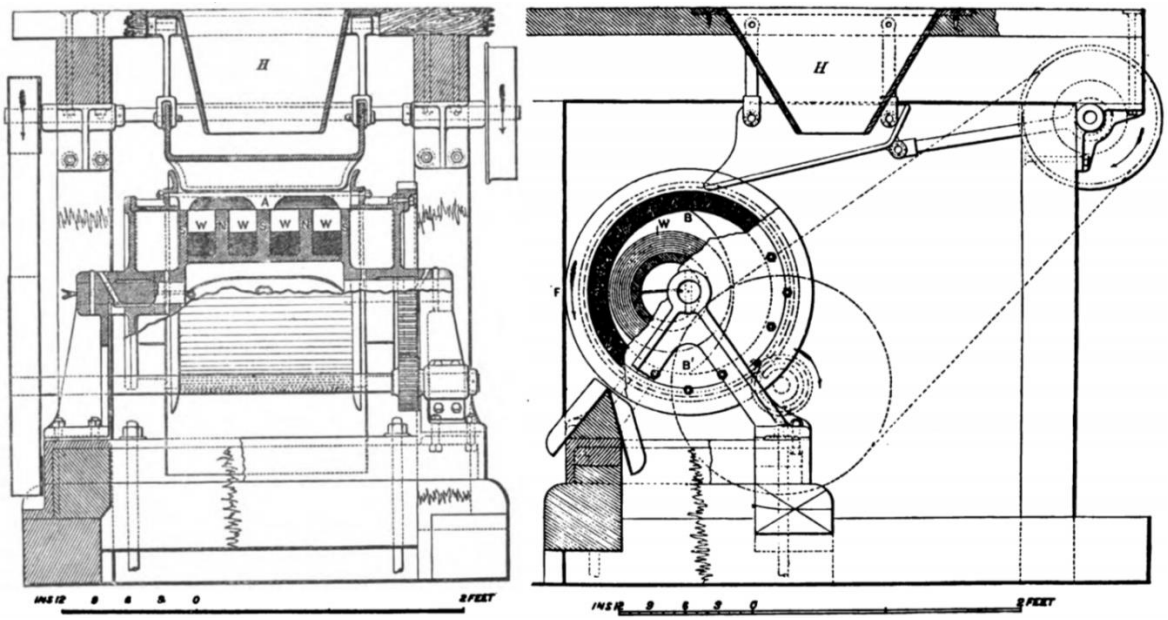


Figure 15. “Wenström separator. Sectional longitudinal and end elevations.”

“I. Concentration of Strongly Magnetic Minerals.

A. Dry methods.

1. Machines employing moving magnets.

One of the earliest and most efficient of these machines, which is still largely used, is the Wenström machine devised in Sweden in 1883. It is shewn in sectional elevation in Fig. [15] and in perspective in Fig. [16]. It consists of a horizontal drum built up of alternate bars of wood and soft iron; the latter have projections at the back, alternate bars having respectively two and three such projections (A, Fig. [15]). A stationary electro-magnet in the form of a hollow cylinder, E, is placed horizontally nearer to the front than to the back of the drum. This electro-magnet is furnished with five pole pieces, of the shape shewn in Fig. [15], the front part B, B being curved to fit the inside of the drum. The electro-magnet is so wound that these pole pieces are of opposite polarity as indicated by the letters N and S in Fig. [15]; the projections at the back of the soft iron ribs of the drum are thus in contact alternately with one or the other set of pole pieces and are therefore alternately of N or S polarity as long as they are travelling (in the direction of the arrow) from B to B'. The ore to be treated is tipped into the hopper H and is fed on to the drum of the machine by a simple shaking tray; the non-magnetic material rolls over the face of the revolving drum and drops into the front shoot; the magnetic material adheres to the barrel and is carried round with it until it has passed the point B', where the iron bars pass out of contact with the pole pieces of the electro-magnet, and are thus no longer themselves magnets, and accordingly release the magnetic particles, which drop into the rear shoot. The machine is made in two sizes; the smaller, having a drum about 20 inches in diameter by 15 inch face and taking a current of about 10 amperes at 35 volts, will treat from 2 to 3 tons per hour in pieces not exceeding ¾ lb. in weight; the larger, with a drum about 30 inches in diameter by 24 inches face, will treat up to 7 tons per hour, in pieces not exceeding 7 lbs. in weight; on finely crushed ore its capacity is rather less, say about 5 tons per hour. The drum makes 30 revolutions per minute, and the current required is 15 amperes at 110 volts. In addition to the power needed to generate the electric current, about ½ H.P. is required to drive the drum. This machine is one of the very few magnetic separators capable of treating lump ore, for which purpose it is still extensively used.”

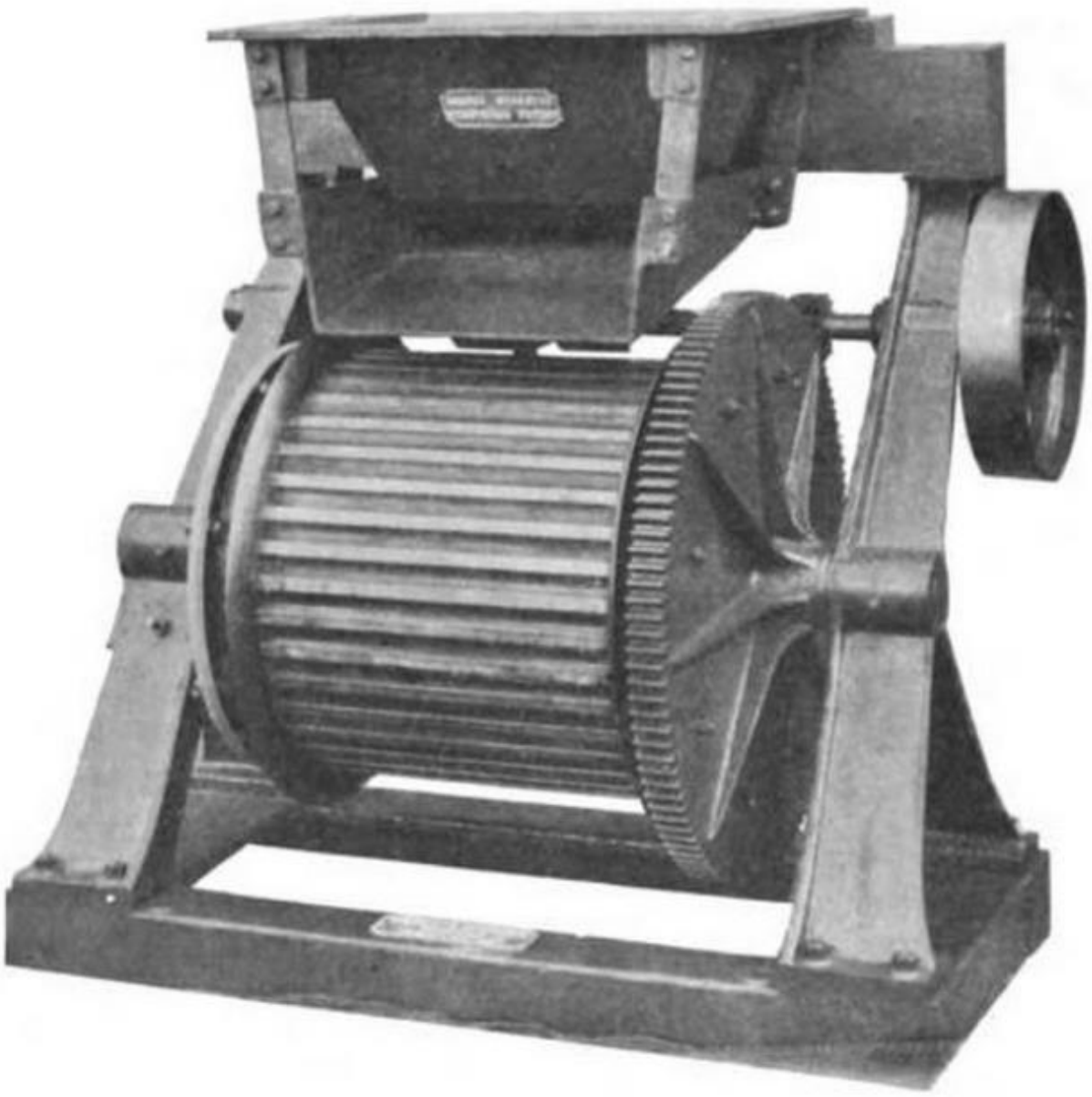


Figure 16. An Example of a "Wenström separator. Perspective."[55]

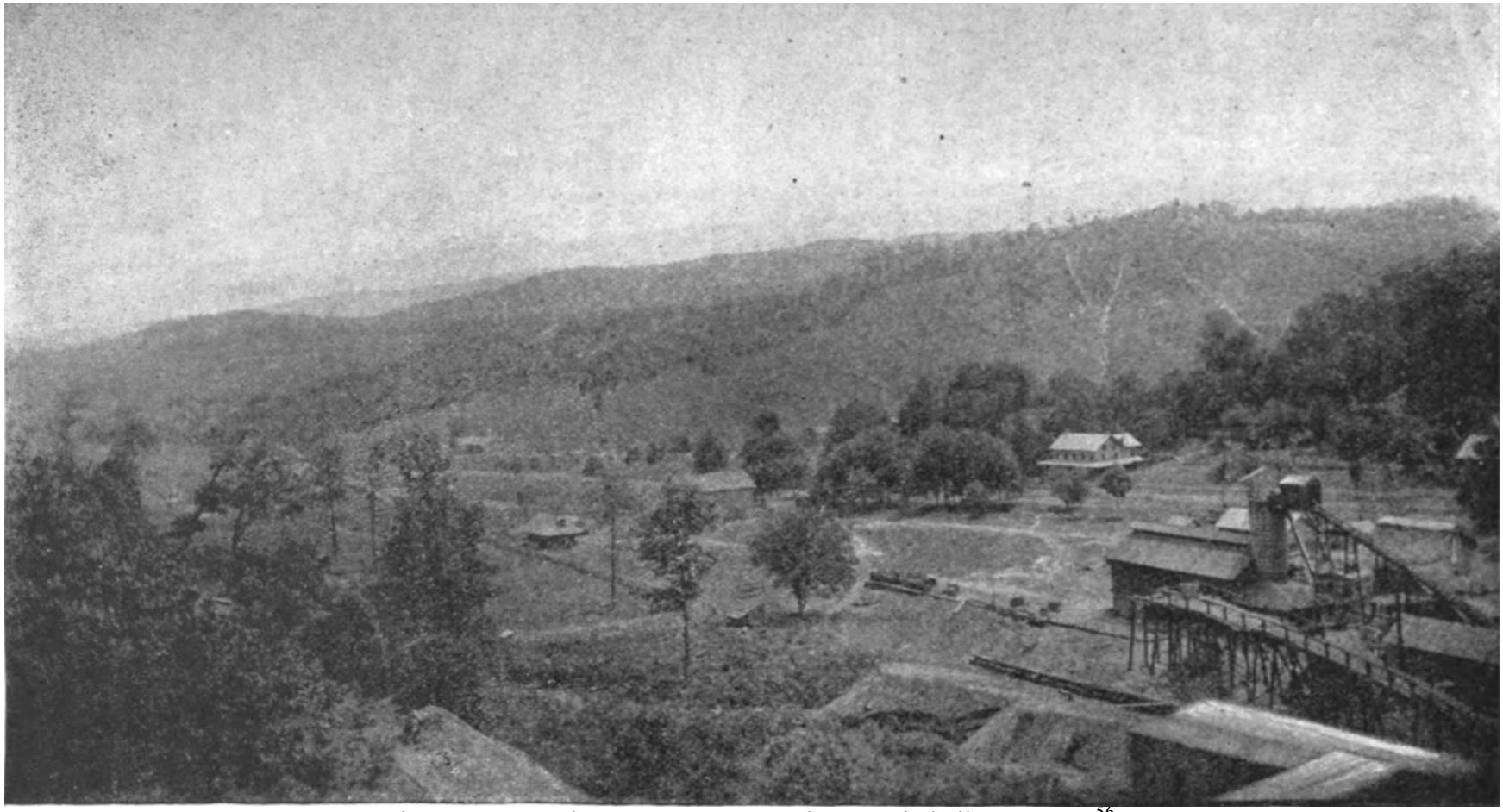


Figure 17. “Cranberry Furnace – Cranberry, Mitchell Co., N.C.”[56]

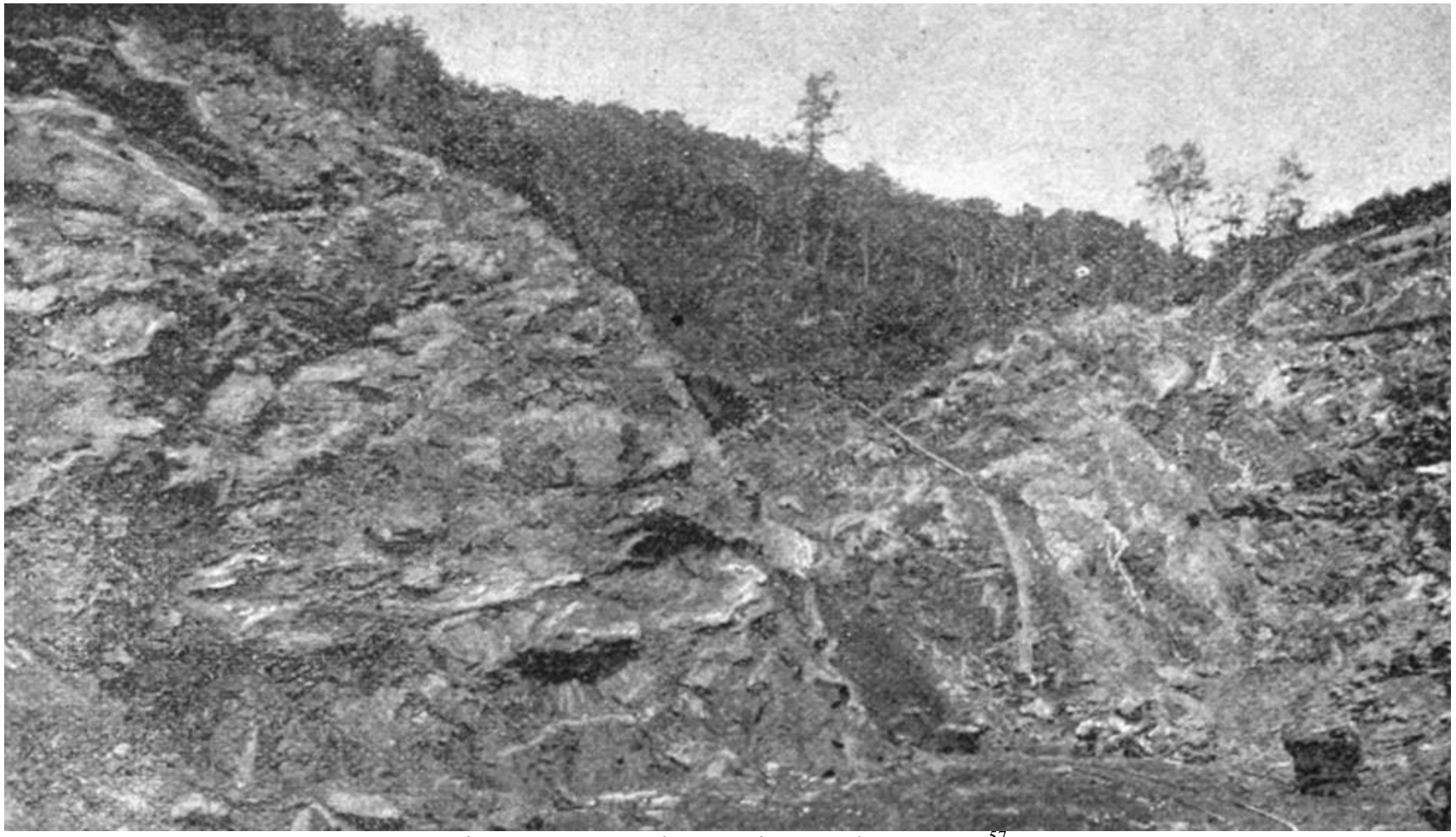


Figure 18. “Magnetic Ore Mine, Cranberry, N.C.”[57]

1890. "Steel Ores in the South – A description of the Region where they Abound. The Roan Mountain Iron Region, the Equal of Menominee, Gogebic or Marquette – Its Value just Dawning. By Henry E. Colton…"

"The Cranberry Iron Mine has a world wide reputation. It ranks with all the great ore deposits of the world, and beyond many of them, for its great purity.

The Cranberry Magnetic Ore.

The Cranberry magnetic ore is one of the most noted bodies of that ore. It was known for many years before there was any possibility of reaching it except by the roughest of wagon roads. The original forge was erected before 1812, and the first anvil block and hammer were packed over the mountain from Virginia on horseback. In excavating for the last forge the foundation timbers of this old anvil-block were dug out, five feet under ground, perfectly sound. The iron made was famous throughout the South, and brought a higher price than any from the adjoining counties of Carter and Johnson, in Tennessee, which irons were made from limonite, except at Hampton, and had a high reputation…

This property was bought in 1867 from Col. J.C. Hardin and others, General R.F. Hoke, of North Carolina, acting for the purchasers. Gen. Hoke immediately erected a new forge and made a large quantity of hammered bar, which he took North to show the quality of the iron. Some of this was made into steel, and proved to be of the best quality. Finally the property was sold to General A. Pardee and others, together with the charter and franchises of the East Tennessee and Western North Carolina Railroad. This road was chartered in 1866 and 16 miles graded, of which 5 were laid with iron rails; it was then built with a 5-foot gauge. Defaulting in the interest on the bonds loaned by the State, it was sold to General Jackson, Col. J.C. Hardin and others and later sold with the mine to General Pardee and associates. These gentlemen decided to make it a narrow gauge, and, the charter having been so amended, they let it out by contract, and it was completed to Cranberry, 38 miles, in June, 1882, at a cost of about $1,000,000. This road connects with the East Tennessee, Virginia and Georgia Railroad at Johnson City, 25 miles south of Bristol, at which place are ample tracks and platforms for transferring ore.

Work was Commenced on the Cranberry ore by driving in a tunnel at nearly right angles to the vein and about seventy-five feet below the nearest out-crop on the east slope of the ridge. This tunnel was driven in 325 feet, of which 50 feet were in the ore. A year later a tunnel was driven in directly on the northeast end of the out-crop where it comes out at the butt of the hill. This was in ore from the start, and is still in use. Tunnel No. 1 is and has been driven to a length of about 500 feet, two side entries have been driven, only the west ore being now worked. The work of quarrying in the open air is also carried on, but is chiefly stripping and uncovering the vein.

This work was commenced on the east side of the out-crop, and is being pushed south across the vein. The south face of this quarry is about 150 feet long, and the highest wall of solid ore is 50 feet and the lowest about 25 feet. The ore body is here estimated to be fully 300 feet thick. In the main or No. 1 tunnel a diamond drill was run in 350 feet deep, and was all that distance in ore and did not go through. Mr. Nimson, formerly from Allentown, Pa., is general manager of the whole business.

The Furnace at Cranberry uses charcoal, partly made in pits and partly in conical kilns, and is run by water and steam. It averages ten tons per day. The pig is of the best character.

When first ascertaining its quality large quantities of this ore were sent to Allentown and tested alone and mixed with limonite in the furnaces of the Messrs. Pardee. It worked well in either case. A large quantity is also sent to Pulaski, and also to Shenandoah Furnace at Milnes. It is used there mixed with limonite. In first using it at Cranberry the usual quantity of lime was used and much trouble experienced. It is now used with but little more lime than the calcite it contains in itself. The company owns at Cranberry about 4,000 acres of land and many houses. It intends to build furnaces as soon as good coke can be obtained at cheap rates. The total investment is said to be about $1,500,000…"[58]

Figure 19. Engine #1, Watauga, of the ET&WNC at the Cranberry Station, Between 1889 and 1903.[59]

17 September 1890. The Bulletin of the American Iron and Steel Association.

"J.P. Witherow & Co., the Pittsburgh contractors, are reported to have made good progress on the new blast furnace of the Carnegie Iron Company, at Johnson City, Tenn. It is a furnace of 125 tons daily capacity. It will attempt the continuous manufacture of Bessemer pig iron from iron-ore obtained from the Cranberry region. Johnson City is only 14 miles from the Cranberry iron-ore mines, in Mitchell county, N.C. The iron ore from these mines will be used in connection with the coke from the Pocahontas region, which is easily accessible by railroad."[60]

30 September 1890 – 20 July 1891. Extract "Table of Analysis of North Carolina Iron of Ores."[61]

Serial No.	Locality.
295	[Cranberry.] From crusher, July, 1892
296	[Cranberry.] From stockhouse, passing over 7/8" screen, July 1892
299	[Cranberry.] From first set of magnets, Venström machine, July, 1892
301	[Cranberry.] Second set of magnets, passing over 10" mesh screen, July, 1892
304	[Cranberry.] From Venström machine, Sept. 30, 1890
305	Cranberry. From Venström machine, July 20, 1891
306	Cranberry. Fine concentrates from new machine, April, 1892
307	Cranberry. Fine concentrates, passing over 10" mesh screen

6 December 1890. The American Engineer.

"The furnace of the Carnegie Iron Co., at Johnson City, is progressing well, and will probably be in blast sometime in February. It will be run entirely on Cranberry ore and Pocahontas coke. The furnace is 16x75 feet, with three Whitwell stoves 18x65 feet, twelve boilers 34 feet long and 54 inches in diameter, with two 18-inch flues. The cast house is of iron, 54x150 feet, and the stock house 80x300 feet. Two Gordon blowing engines are used, having steam cylinders 42 inches, and air cylinders 84 inches in diameter and 48-inch stroke. The company's plant is located in a section rich in ores, and only 90 miles from the great Virginia coal fields on the main line of E.T.V.&T. R.R. and C.C.C. R.R. Superintendent Henry W. Hargreaves in a communication to this paper states that a Bessemer iron can be made there for $10 a ton.–American Manufacturer."[62]

1890. The Iron and Steel Institute in America in 1890: Special Volume of 'Proceedings.'

"…Railway transportation has as yet reached the belt containing the southern Bessemer ores at but one point – the Cranberry mine, in Mitchell County, North Carolina. I only returned yesterday from a visit to this great mine, along with Mr. Monks and Mr. Darby, for I wished that some members of the Iron and Steel Institute should visit Cranberry mine in order to bear witness to the statements I am about to make to you.

This wonderful deposit of ore has been removed for a width of 400 feet, and to a height of over 400 feet above the railway track. A tunnel has been driven across the deposit in ore for 400 feet near the water-level, and another at right angles for a distance of 1700 feet, also in ore; and the engineer in charge estimates that he has in sight, piled up above the railroad track, over 20,000,000 tons of pure Bessemer ore, where the mineral can be mined by simply quarrying in open out. "To know nothing of the depth of this great deposit. However, my friend General Wilder does, for I was told that a party of gentlemen were being shown over the mine recently, when one of the visitors asked Mr. Nimson, the engineer in charge, how deep the deposit extended. Before Mr. Nimson could answer, General Wilder said, 'I know; the devil is making pig iron at the other end now.' General Wilder is present, and can tell you how he got his information. (General Wilder – From the Geologist). Numerous analyses, as well as practical furnace tests, prove this to be a Bessemer ore of exceptional purity. During the past summer a

small furnace at Cranberry ran for a month using Virginia coke, and the run of mines of Cranberry ore, analysing the pig produced each day, was 027. The entire product of the month's run was sold at Pittsburgh for 24 dollars per ton. This answers conclusively, I think, the question as to the value of the Cranberry ore for Bessemer steel. I believe that the pure coke from this region, and the magnetic ores from Western North Carolina and East Tennessee, and the limestone, can be brought to the furnace at a cost of 5 dollars per ton of iron produced less than the present cost of Lake ores and Pennsylvania coke at any common meeting-point that may be selected. Taking the Cranberry ore at the lowest percentage, and the cost of cars at Johnson City at the maximum, it will even then cost but 6 cents per unit of iron as against 11 cents per unit of iron at the present cost for the Lake Superior ores at the best located furnaces of Western Pennsylvania. I have seen the extension of this ore east and west from Cranberry. Recently it has been opened at several points along the line, extending into Carter County, Tennessee, for fifteen miles west from Cranberry, and at more than one place it is proved to be a thick deposit of very pure iron. I am informed that it is present in great quantities on the drainage of the French Broad, the Big Pigeon, and the little Tennessee Rivers, and Mr. Jacob Higson of England, who is largely responsible for the large development you are now witnessing in this valley, informs me that he has seen it yet westward in North Carolina, on the extension of the Knoxville Southern Railway, near the Georgia line.

The development of this region has been retarded by the absence of railway transportation necessary to bring together the coals and the ores…"[63]

1890. The Future Situs of the Principal Iron Production of the World: Where is it?, by Edward Atkinson.

"The Cranberry Iron Co. has had the Cranberry mine, (within two miles of the Tennessee line), in Mitchell County, N.C., open for six years, experimenting with and developing these ores; they have cut transversely across this vein of magnetic black oxide, a distance of four hundred feet between walls ; they have stripped it for seven hundred feet on the rim, and have taken out about two hundred and fifty thousand tons of ore in the past six years, having run a small furnace at their mine continuously for about the same length of time with charcoal as fuel, and shipped pig iron to Pittsburg and McKeesport, Pa., for use in making the highest grades of special crucible steel. This charcoal is made from the deciduous trees—chestnut, hard maple and various oak timber of the region. It is found that coke made from this timber runs higher in phosphorus than the Pocahontas coke made in Virginia. The Cranberry Iron Co., used some of the Pocahontas coke, and made a blast with it for fuel, and found the phosphorus in the pig iron only about two-thirds of that made with charcoal.

The Roane Iron Co., in Chattanooga, shipped some fifty thousand tons of this Cranberry ore to the Rockwood furnaces, and smelted with an inferior coke, and found it very low in phosphorus, and an admirable bessemer iron. Twenty thousand tons were shipped to Allentown, Pa., and there tested for the same purpose with most excellent results.

The Carnegie Iron Co., at Johnson City, Tenn., are now building a large modern furnace, with a view to making a low phosphorus iron for bessemer and crucible steel purposes from these ores."[64]

1891. Philadelphia Securities…[65]

"Cranberry Iron and Coal Co., 242 S. 3d st. General Office, Cranberry, Mitchell Co., N.C. lncorptd. Feb. 28, 1873, in North Carolina. Charter Perpetual. Corporate Office, 242 S. 3d st. Object – Mining of coal and iron ores, and manufacturing of pig-iron. Plant located at Cranberry, N.C. One blast furnace, built in 1883 – 4, first blown in April 16, 1884. Annual capacity, 6000 net tons. Capital not stated. Annual Meeting, 3d Tues. in Feb., at 240 S. 3d st. Fiscal year ends Dec. 31. Dividends not stated. No funded debt. Officers – Frank Firmstone, President; John L. Wise, Secretary and Treasurer; C.H. Nimpson, General Manager. Directors – Ario Pardee, Ario. Pardee, Jr., R.F. Hoke, Geo. Richards, Frank Firmstone, John R. Fell, Charles L. Peirson."

25 February 1892. Watauga Democrat.

"A man by the name of Bridges got blown up in the Cranberry mines a few days ago. His body was badly mangled, and he only survived about twenty-four hours."

March – 15 April 1892. "Southern Magnetites and Magnetic Separation," by Harvey S. Chase.[66]

"A test of the revolving [Wenström] magnet was made April 15, 1892, all the tails being caught and weighed up, and resulted as follows:

	Pounds.	Iron in Fe_3O_4. Per cent.	Iron in FeO. Per cent.	Total iron. Per cent.
Shot,	1092	49.8	4.9	54.7
Dust,	1014	61.0	2.4	63.4
Tails,	874	11.0	11.1	22.1

… During the month of March, 1892, 920 tons of ore from the crusher and 947 tons of 'dirt' from the mine, or a total of 1867 tons, were sent to the washer and separators. From this was recovered 1029 tons of 'clean ore,' averaging 45 per cent. of metallic iron, 47 tons of 'shot' averaging 55 per cent. of metallic iron, and 113 tons of 'dust' averaging 63 per cent. of metallic iron; also 271 tons of tails and 406 tons of fines washed away (by difference) averaging together less than 20 per cent. of metallic iron…"

21 July 1892. Engineering News and American Railway Journal.[67]

"Basic Steel and Bessemer Pig Manufacture in the South… During the year 1892 a furnace will be started demonstrating, on a large scale, the value of the magnetic deposits of western North Carolina for the manufacture of a high grade Bessemer steel. The value of these ores has been sufficiently demonstrated. During the past year the furnace at Cranberry, N.C., has run on Virginia coke, and the run of the mine of Cranberry ore, and analyses of each day's run for month, gave an average for the month of only .022 phosphorus in the pig; the highest for any one day being .027. The entire product is sold as a 'special' Bessemer, on account of its great purity, at a price in advance of the Lake Superior Bessemer. The demonstration on a large scale that a high grade Bessemer can be made at a low cost in this Central Appalachian district means much for the future development of the district. Nowhere else is a low phosphorus ore so near to superior coking coals."

Figure 20. "This 1891 view of Cranberry looking north from Bakersville Road affords an overall view of the locomotive coal platform, turntable, engine house, mine buildings, ore chutes, charcoal ovens, charcoal sheds, and the furnace. Mallory Hope Ferrell Collection." Note, the US Geological Survey attributes this photograph to John Karl Hillers. The photograph was apparently accepted in December 1894.[68]

Figure 21. Furnace and charcoal ovens at the Cranberry iron mine. "Courtesy of the Caldwell Heritage Museum."[69]

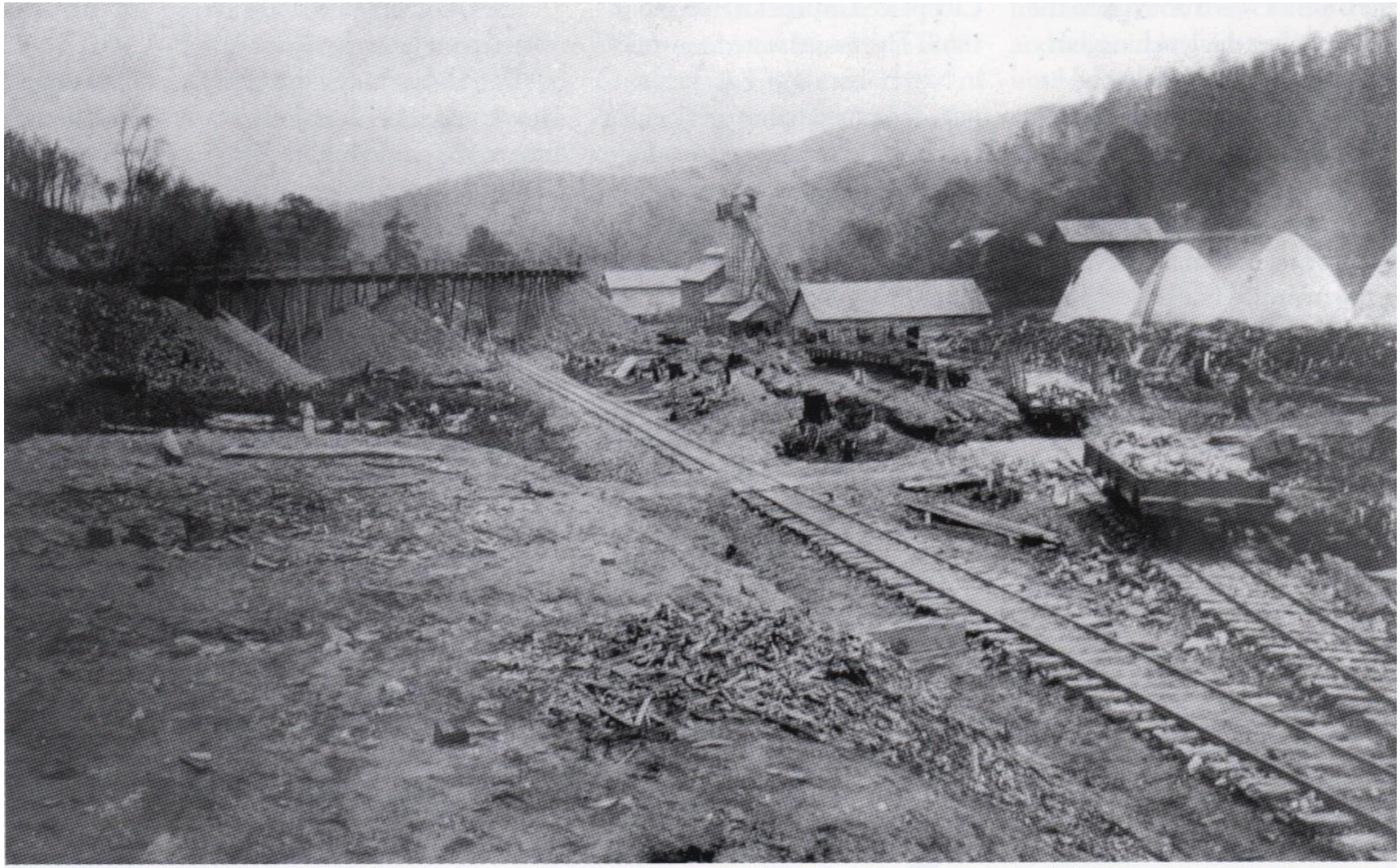


Figure 22. “The charcoal ovens are still working in 1891, but the furnace is starting to burn coke much of the time. Sirgis Cole Collection.”[70]

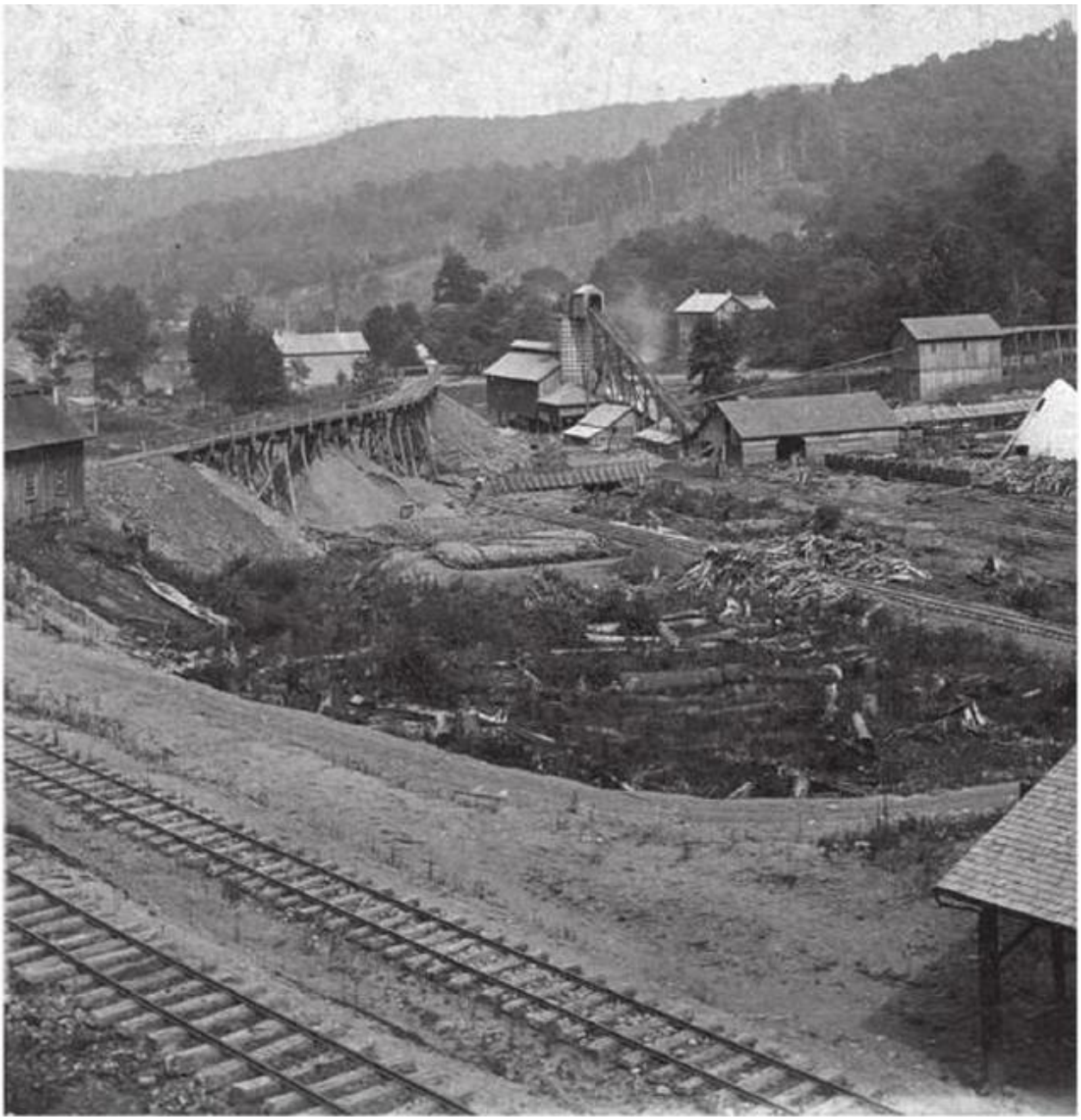


Figure 23. "Another view of the mining operation at the Cranberry mines is seen here. The track of the East Tennessee and Western North Carolina Railroad can be seen at the bottom of the photograph. Courtesy of the Caldwell Heritage Museum."[71]

Figure 24. Cranberry, perhaps between 1891 and the mid-1890s.[72]

Figure 24a. A detail of the iron furnace buildings in the photo above

Figure 25. "Cranberry iron mine and furnace don't appear to be very busy during the summer of 1891. The mine at left is just beginning to go beneath the surface for ore, and the furnace in the center of the photo is converting from burning charcoal to coke. Mallory Hope Ferrell Collection." Note that only a single charcoal kiln is visible in this photo and the US Geological Survey attributes this photograph to John Karl Hillers. The photograph was apparently accepted in December 1894.[73]

Figure 26. "Ore is brought from the diggings to the trestle, where it is dropped to be loaded into ore buggies which are lifted up the incline to feed the furnace (right). The cylindrical hopper in the middle is the roast. The furnace stack has been enlarged for conversion to hot blast. Cranberry creek winds its way through the mine/furnace complex. Avery County Historical Society Collection."[74]

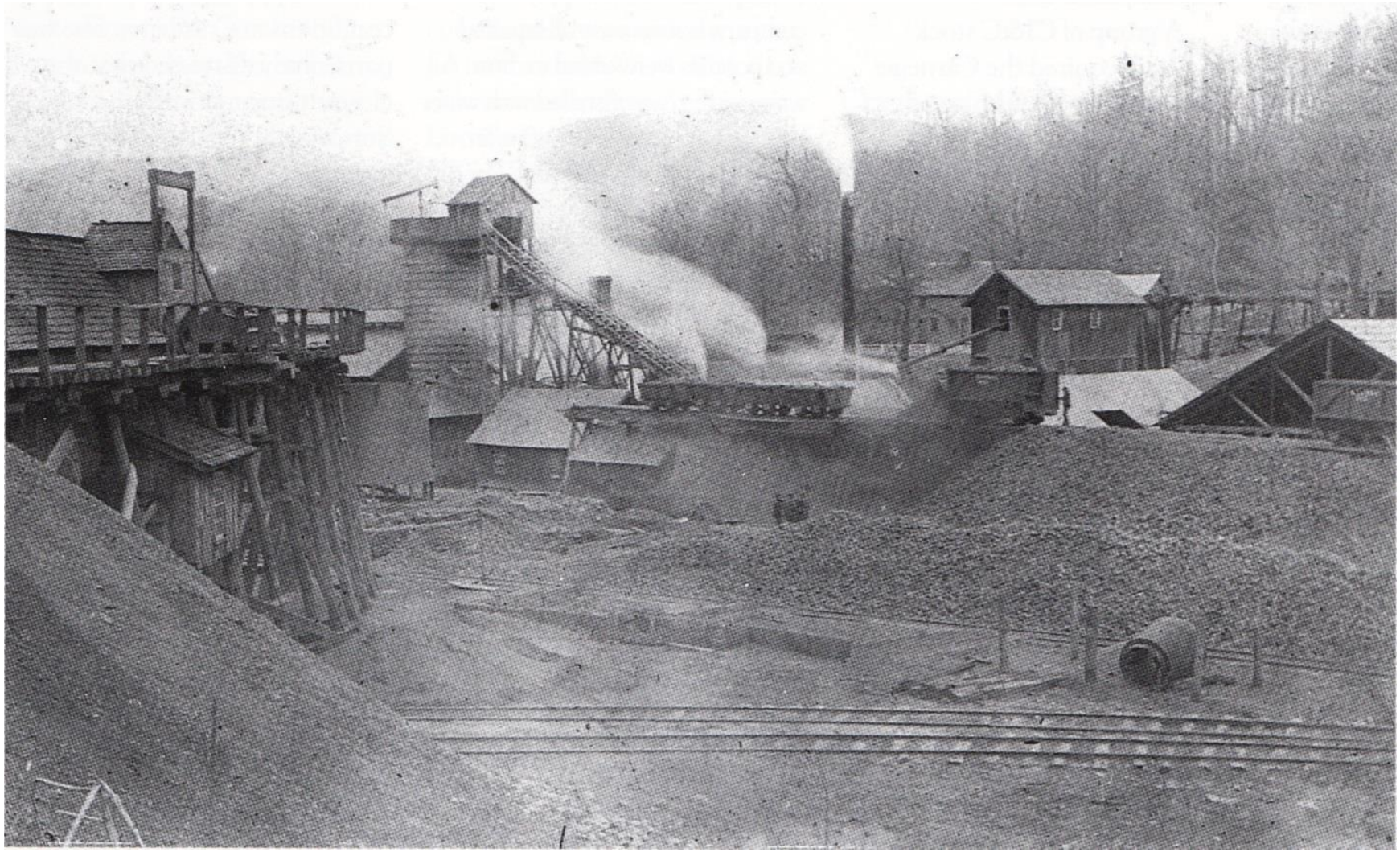


Figure 27. "Cranberry Furnace is a busy place c. 1890. The mine is on the left, the furnace in the middle, and the blower house on the right. Note the flume on the right bringing water to power the blower. The furnace has now been converted to hot blast, as evident by the square chimney of the host blast oven behind the incline. Avery County Historical Society Museum Collection."[75]

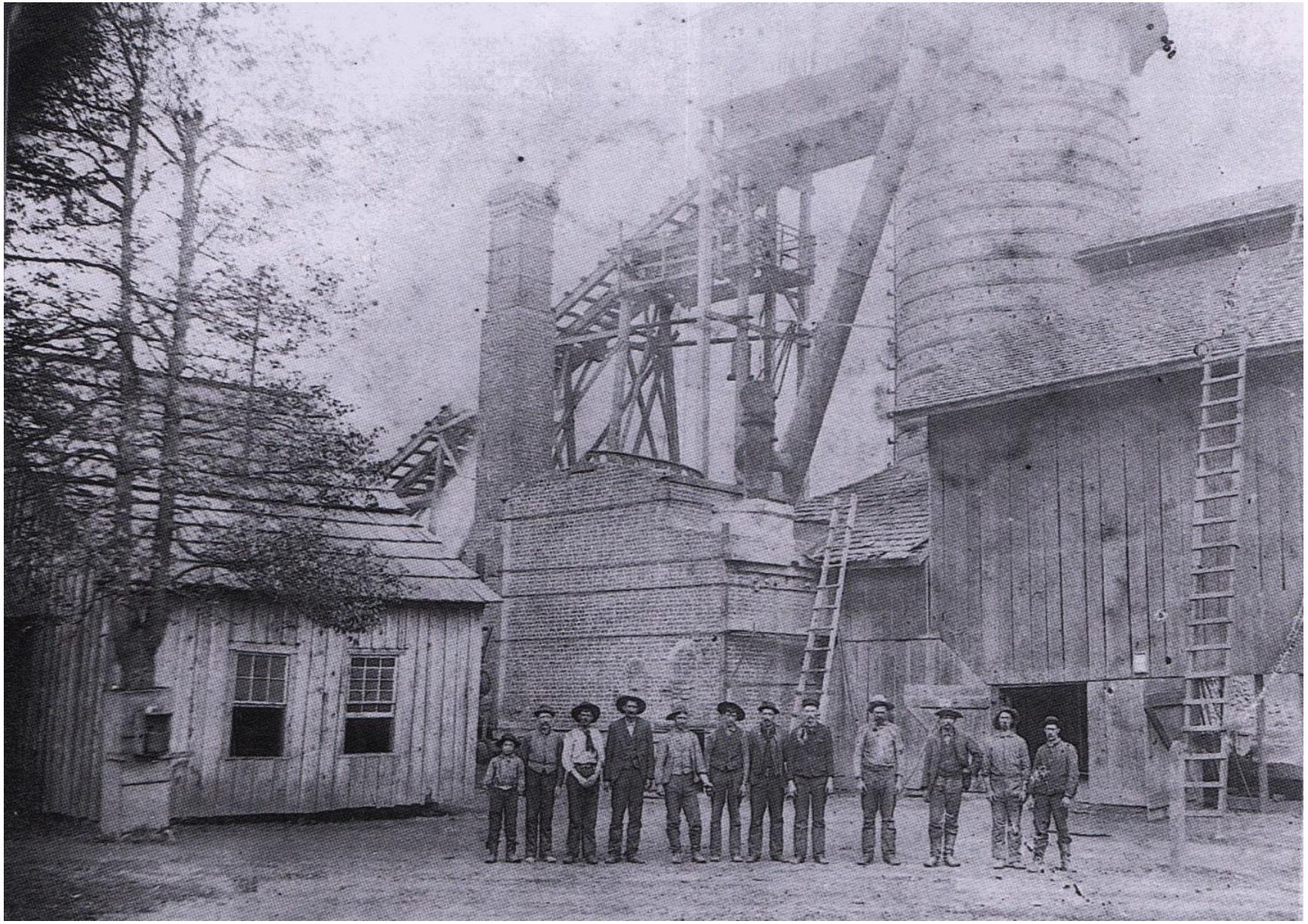


Figure 28. "Workers pose in front of the Cranberry Furnace c. 1890. Details of the incline and furnace clearly show in this photo. The cast house is to the right with the hot blast oven in the middle, being fueled by waste gases from the top of the furnace. The building on the left is the steam driven blower, also fueled by waste gases. Avery County Historical Society Museum Collection."[76]

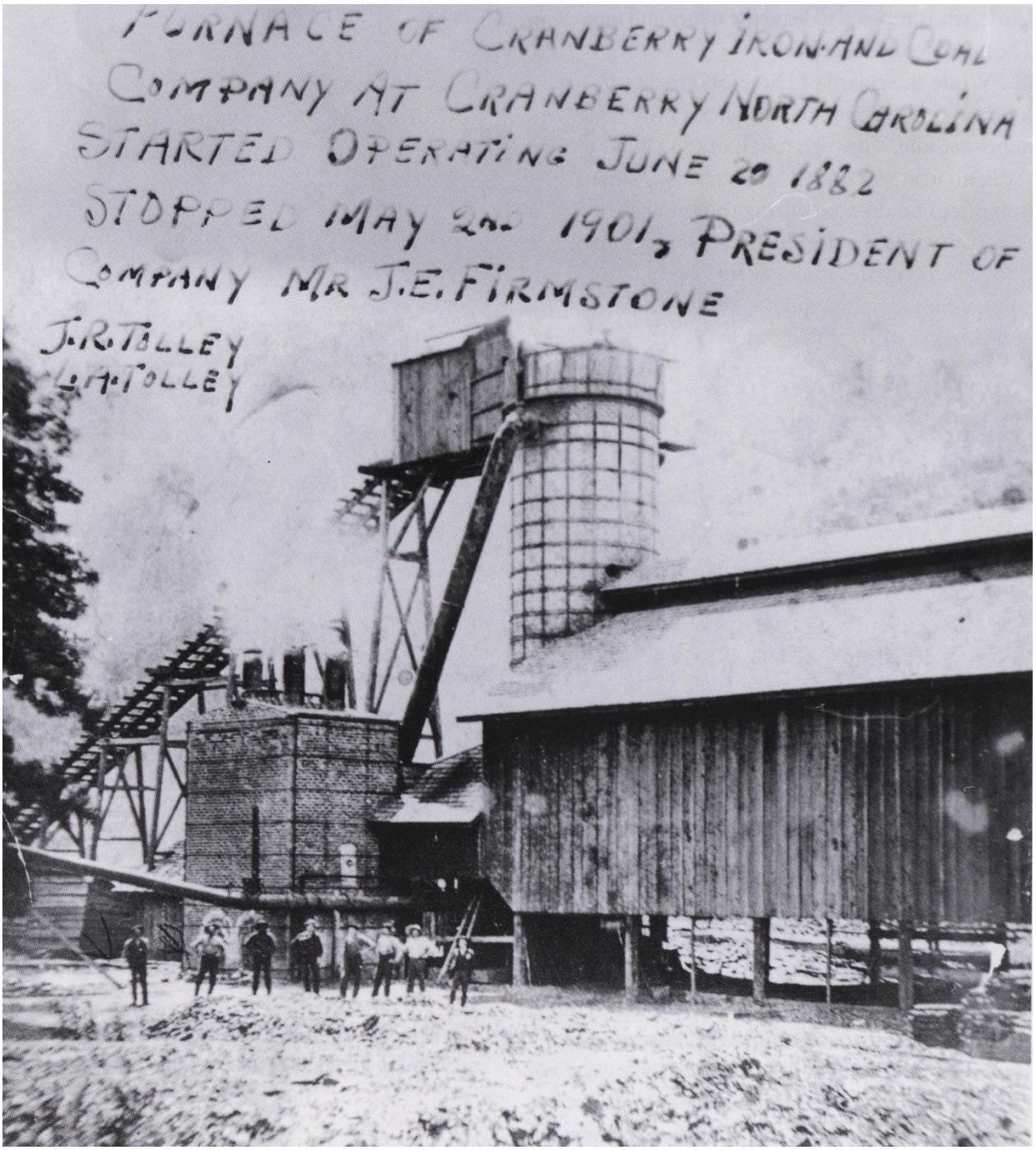


Figure 29. "Eight workers pose in front of the Cranberry Iron & Coal Company furnace in the 1890s. Ben Tolley Collection."[77]

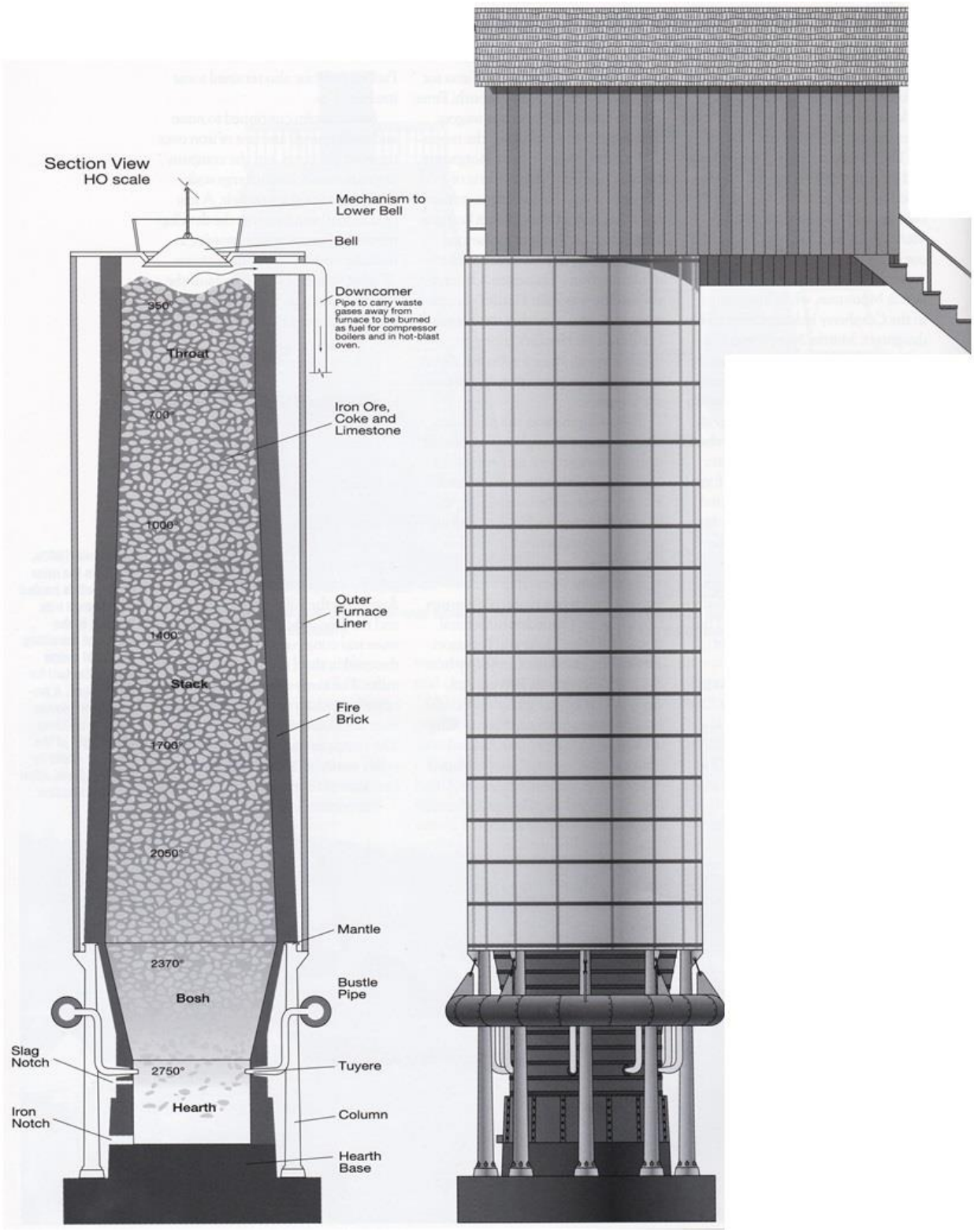


Figure 30. "The Furnace at Cranberry" by Chris Ford,
The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co.[78]

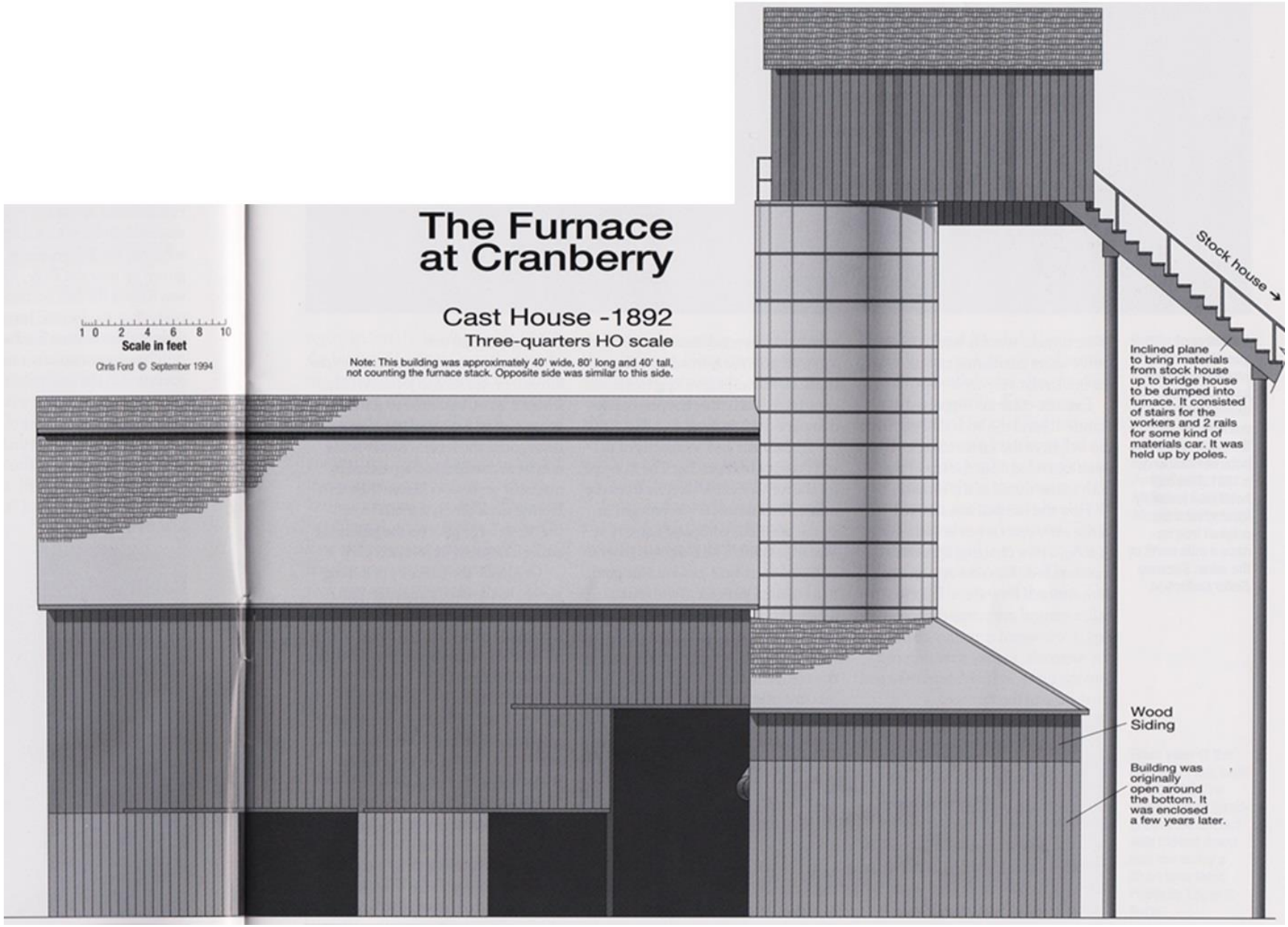


Figure 31. "The Furnace at Cranberry" "Cast House – 1892" by Chris Ford, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co.[79]

Figure 32. “The Cranberry Iron Mine,” by John Karl Hillers. The photograph was apparently accepted in December 1894.[80]

6 August 1892. The Railway Register.

"During the year 1892 a furnace will be started demonstrating, on a large scale, the value of the magnetic deposits of western North Carolina for the manufacture of a high grade of Bessemer steel. The value of these ores has been sufficiently demonstrated. During the past year the furnace at Cranberry, N.C., has run on Virginia coke, and the run of the mine of Cranbury ore, and analyses of each day's run for a month, gave an average for the month of only .002 phosphorus in the pig; the highest for any one day being .027. The entire product is sold as a 'special' Bessemer, on account of its great purity, at a price in advance of the Lake Superior Bessemer. 'The demonstration on a large scale that a high grade Bessemer can be made at a low cost in this central Appalachian district means much for the future development of the district. Nowhere else is a low phosphorus ore so near to superior coking coals.'"[81]

1892. "The Present State of the Iron Industry in North Carolina."

"There are at present two mines and one blast furnace in operation in the State. The Cranberry mine, at Cranberry in Mitchell county, is an extensive deposit of magnetite of Bessemer quality, which has been worked for generations in the primitive Catalan forges situated near by.

About 1880 this property came into the possession of the Cranberry Iron and Coal Co., which has developed it continuously and extensively since that time, by open cuts and tunnels; but mining has never been followed on the larger scale that this deposit would justifiably warrant. Early in 1884 a small blast furnace, 50 feet high by 10 feet 2 inches wide at the bosh, with a daily capacity of from 14 to 15 tons, was blown in here, and has been operated without interruption since, running at first on charcoal, but during the greater part of the past two years on coke from Pocahontas, Va., and producing a remarkably pure Bessemer iron of special grade. This furnace was also built here more with a view of further developing the property, by testing the actual quality of the pig iron that could be made from these ores, than for the purpose of establishing a large and regular industry. The policy of the company appears to have been one of development and exploratory work ever since they first took hold of the property. A narrow-gauge railroad, the East Tennessee and Western North Carolina, about 32 miles in length, connects the mines and furnace with the East Tenn., Va. and Ga. railroad, at Johnson City, Tenn. The total output of ore from this mine for the year just ended, 1892, was 18,433 long tons, which, valued at $1.40 per ton at the mine, was worth $25,806.20. Of this amount, 12,088 tons were shipped to furnaces outside of the State. The total production of the furnace for 1892 was 3250 short tons of Bessemer pig iron, which, valued at $16.00 per ton at the furnace, was worth $52,000.00. Of this amount, 2900 tons were coke iron and 350 tons charcoal iron.

During the past year, magnetic concentration of the ores, though yet in an experimental stage, has been successfully introduced here, and most of the ore that entered the furnace was of this description."[82]

"The Cranberry Magnetite Belt contains by far the most important deposits of ore in this region, and has been the most extensively developed.

Its eastern extremity is found at Cranberry in the northern part of Mitchell county; thence it is traced without difficulty in a direction approximately N. 34^0 W., for 2½ miles to the Tennessee line, which it crosses near the line of the W.N.C. and E. T. railroad; it passes through the southern portion of Carter county, Tenn., deflecting gradually westward, and thence

southwestward to the headwaters of Tiger creek, recrossing into North Carolina over Iron mountain, at an elevation of nearly 4000 feet (above sea-level) to the headwaters of Greasy creek, and continuing in a normal southwesterly direction to the Toe river, near the mouth of Pigeon Roost creek, a total distance of some 22 miles.

The Cranberry Mine is situated in the extreme northern part of Mitchell county, at Cranberry P.O., on the eastern, slope of Cranberry ridge, a part of the great Smoky mountain range, 4 miles southwest from Watauga county, and 2½ miles east from the Tennessee State line. It is at the terminus of the East Tennessee and Western North Carolina railroad (narrow gauge), on the west bank of Cranberry creek, a tributary of Elk creek. (See plates XVI to XX.)

This deposit of magnetic iron ore may justly, from its extent and quality, be noted as one of the most important in the State. The ore was worked in a small way, in Catalan forges located near by, as far back as 1820. The excellent quality of blooms produced from Cranberry ore soon became known and attracted considerable attention. In 1866 it was tested in the United States Navy Ordnance Yard at Washington, D.C., with the most satisfactory results.

In the same year a railroad was chartered by the owners from the mine to Johnson City, Tenn., a distance of about 32 miles, and 16 miles of it were graded.

Lack of capital, however, caused the abandonment of this project. About 1876 the property came into the possession of the present Cranberry Iron and Coal Company, which completed the railroad in 1882 to Johnson City, connecting there with the main line of the East Tennessee, Virginia and Georgia railroad. It was not until then that regular, systematic mining work was undertaken. The forge people had no more than 'hogged over' the ground, thus exposing the outcrop over a large area, but not dreaming of the immenseness of the deposit beneath. Because of its friability, incoherence, and loose, coarse-granular structure, they preferred the weathered surface and outcrop ore to the purer, compact, homogeneous magnetite found at greater depths, which was too hard to treat in the forge. The operations of the Cranberry Iron and Coal Company have gradually developed a body of ore, the extent and quality of which place it on an equality with the large deposits of Lake Champlain, N.Y., and the New Jersey region. In the spring of 1884 a small blast furnace[1] was blown in here, and has been run continuously since, with the short intermissions necessary for relining, repairing, etc."

"1 The plant consists of one furnace of the following dimensions: Height of stack, 50 feet; diameter of bosh, 10 feet 2 inches; diameter of hearth, 3 feet: capacity, 14 to 15 tons per day, in 4 runs of 3½ to 4 tons each. It is equipped with one cast iron pipe heating stove with straight bed pipes and U uprights; four plain cylinder boilers in two batteries of two each, heated by the waste gases, aggregating 60 horse-power; one Weimar vertical blowing engine, with two steam cylinders, diameter 36 inches, stroke 26 inches, revolutions per minute 30 to 32; one double-cylinder water-wheel blowing engine; diameter of cylinders 4 feet, stroke 5 feet, revolutions per minute 4¼ to 4½."

"The ore deposit is an immense lens, the extent of which has not yet been fully determined, of magnetite associated with hornblende, pyroxene, epidote, quartz, feldspar, calcite, garnet, zircon, allanite, serpentine, etc., in varying proportions. It occupies the eastern slope of Cranberry ridge, and from its position is admirably located for mining. The highest outcrop is 380 feet above the water-level of Cranberry creek. (See plate XVI.)

It has been traced in a direction approximating N. 34° W. to and beyond the Tennessee State line, a distance of about 2½ miles (whether this is the same lens or not has yet to be determined by future development; the present theory is in favor of detached bodies or lenses).

In a southeasterly direction the outcrop appears on the eastern bank of Cranberry creek, along the western flank of Little Fork mountain, where it has been slightly explored; it is reported to continue thence toward the Old Fields of Toe, a distance of some 3 miles.

However, the Cranberry mine is the only point at which the deposit has been opened for practical purposes as yet.

The present workings cover an area on the slope of the mountain of from 7 to 8 acres, and consist of two tunnel openings and four main opencuts in successive levels or benches. The accompanying plates present this more clearly and will be referred to.

Plate XVI represents a topographical map showing the mines, railroad and furnace-plant owned and operated by the Cranberry Iron and Coal Company.

Plate XVII shows the vertical section through the imaginary line I-J of Plate XIX.

Plate XVIII shows the vertical sections through the imaginary lines A-B, C D, E-F, and G-H of Plate XIX.

Plate XIX shows a horizontal projection of the mine workings at different levels.

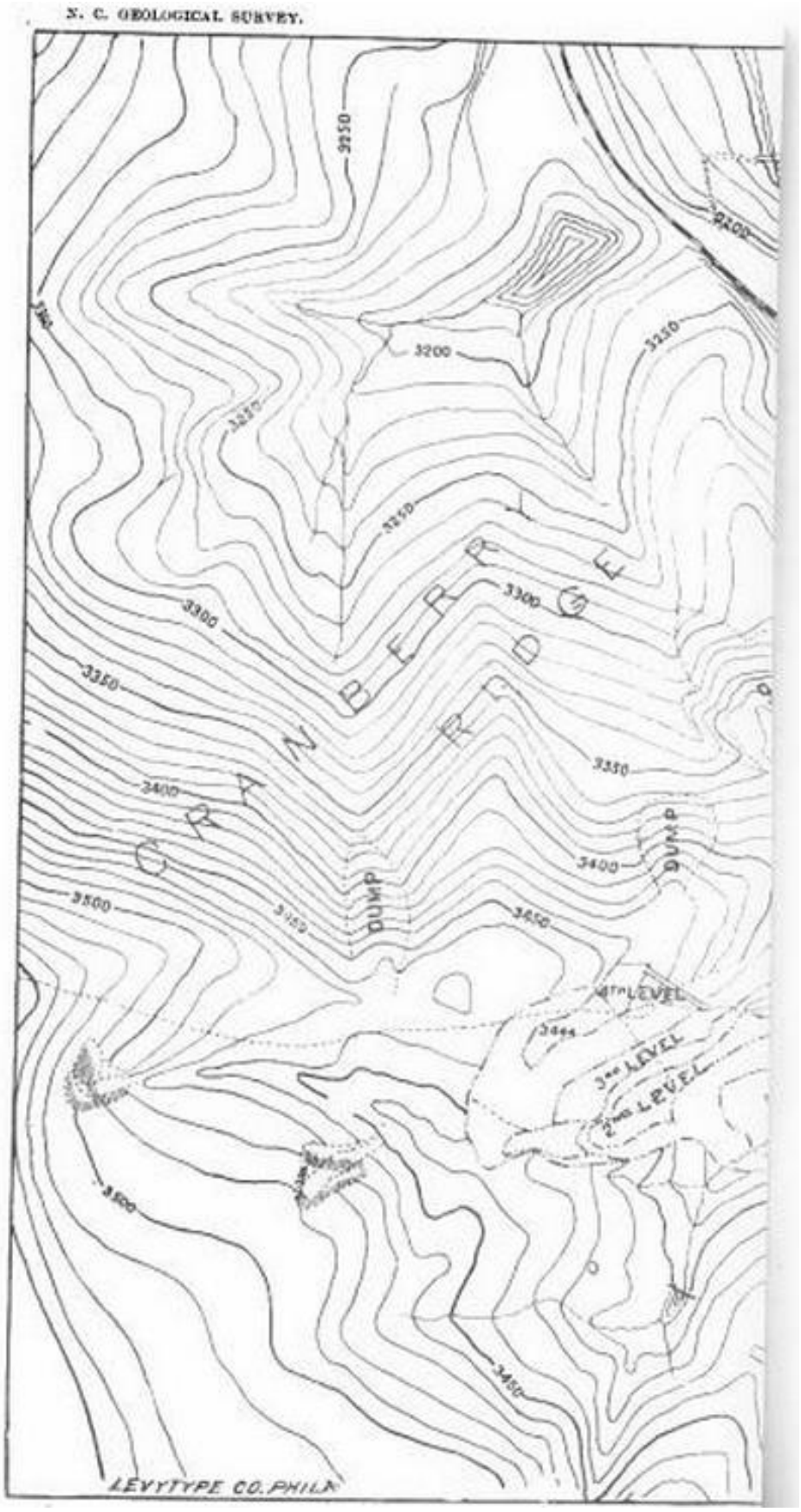
Referring to Plates XVII, XVIII, and XIX, the lowest workings are in the lower tunnel, which enters the hill at an elevation of 3210 feet (25 feet above the level of Cranberry creek), crosscutting the ore deposit in a direction S. 72° W.; its length is 405 feet along the line A-B; at its face a horizontal bore hole has been driven 142 feet and 3 inches in the same direction, being in ore ground all the way, and proving a dip of about 45° S. W. The horizontal and vertical extent of the lower workings will be seen by careful study of the plates. They open into the upper tunnel workings near the intersection of the lines I-J and C-D, at an elevation of 3250 feet.

The upper tunnel enters the hill at right angles to the lower tunnel, at an elevation of 3250 feet (55 feet above the level of Cranberry creek). It extends 430 feet in a direction N. 12° W., along the line I-J, and opens into the first level open workings at an elevation of 3300 feet. (See Plate XVII.)

The first, second, third and fourth level open workings enter the eastern side of the hill at the elevations 3293, 3343, 3384, and 3441 feet respectively, the highest point in the upper cut being 3485 feet (300 feet above the level of Cranberry creek and 275 feet above the level of the lower tunnel).

There are several smaller open cuts on the southern and western faces of the hill, above the tunnel workings. The accompanying plates will explain themselves without further detailed description.

In short, the ore body has been explored and opened up in the main workings 875 feet in length by 300 feet in breadth by 275 feet maximum depth (about 165 feet average depth), representing approximately 1,000,000 cubic yards. Assuming that the gangue and ore are equally divided, half and half, and taking the specific gravity of magnetite at 5.1 and of the gangue at 3.0, this volume would contain 4,800,000 tons (gross) of ore material, of which over 3,000,000 tons are pure ore.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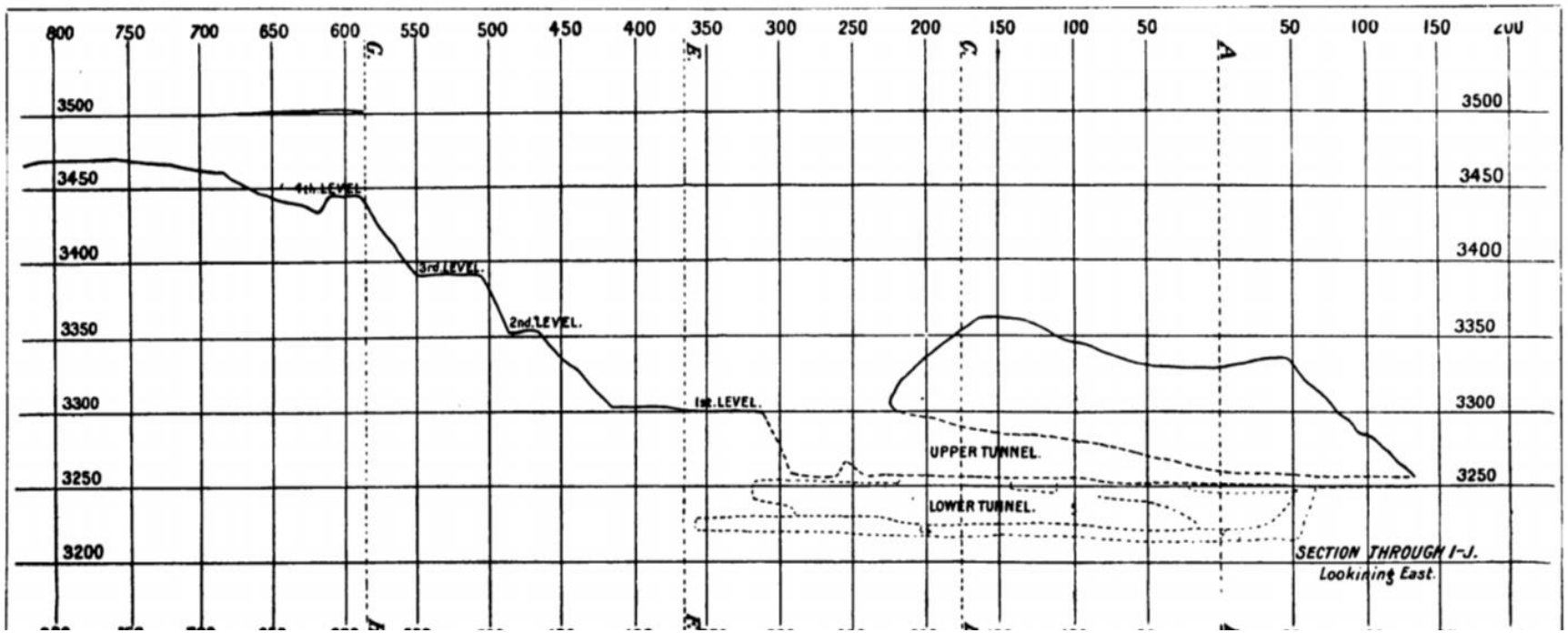
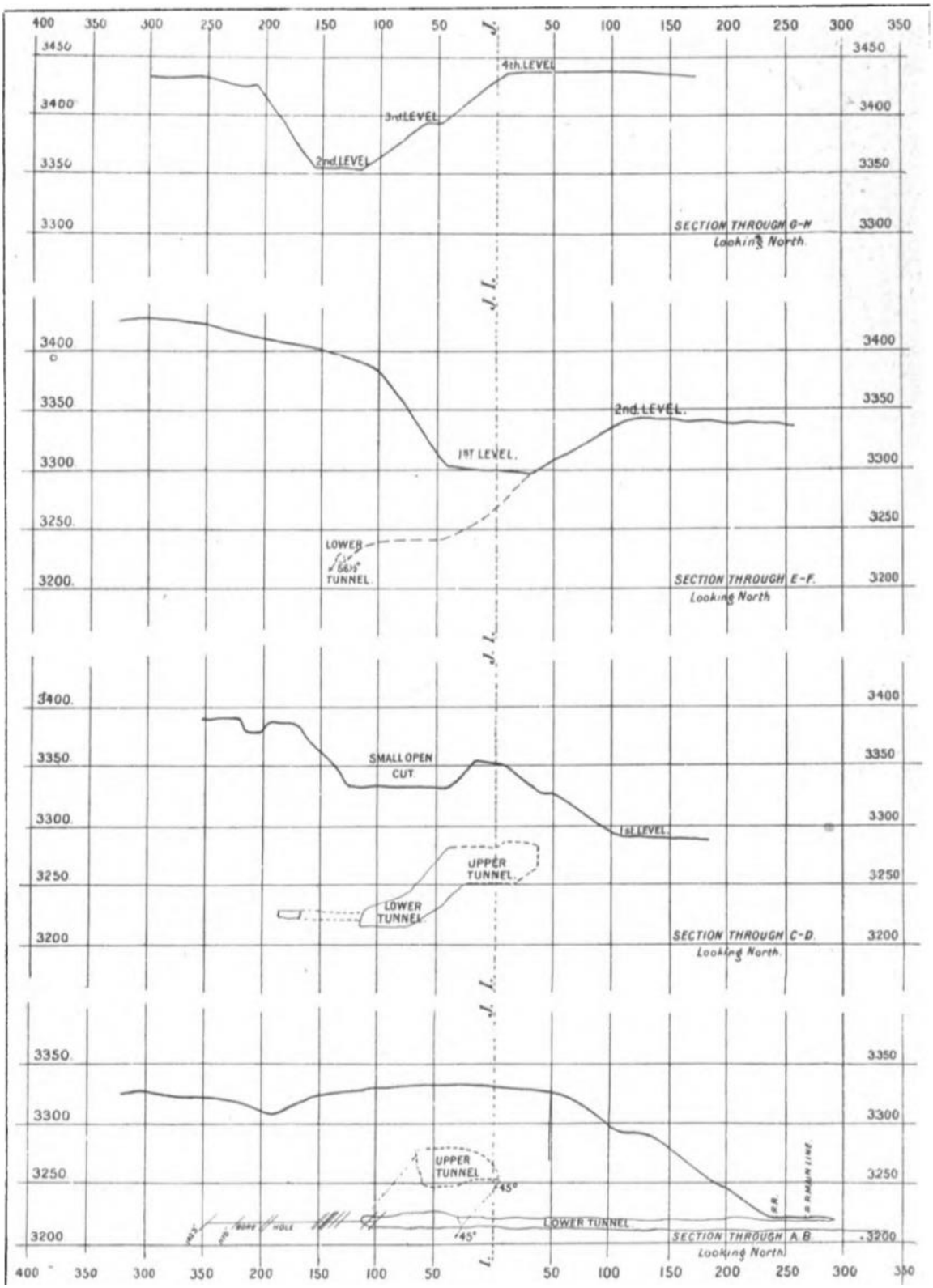
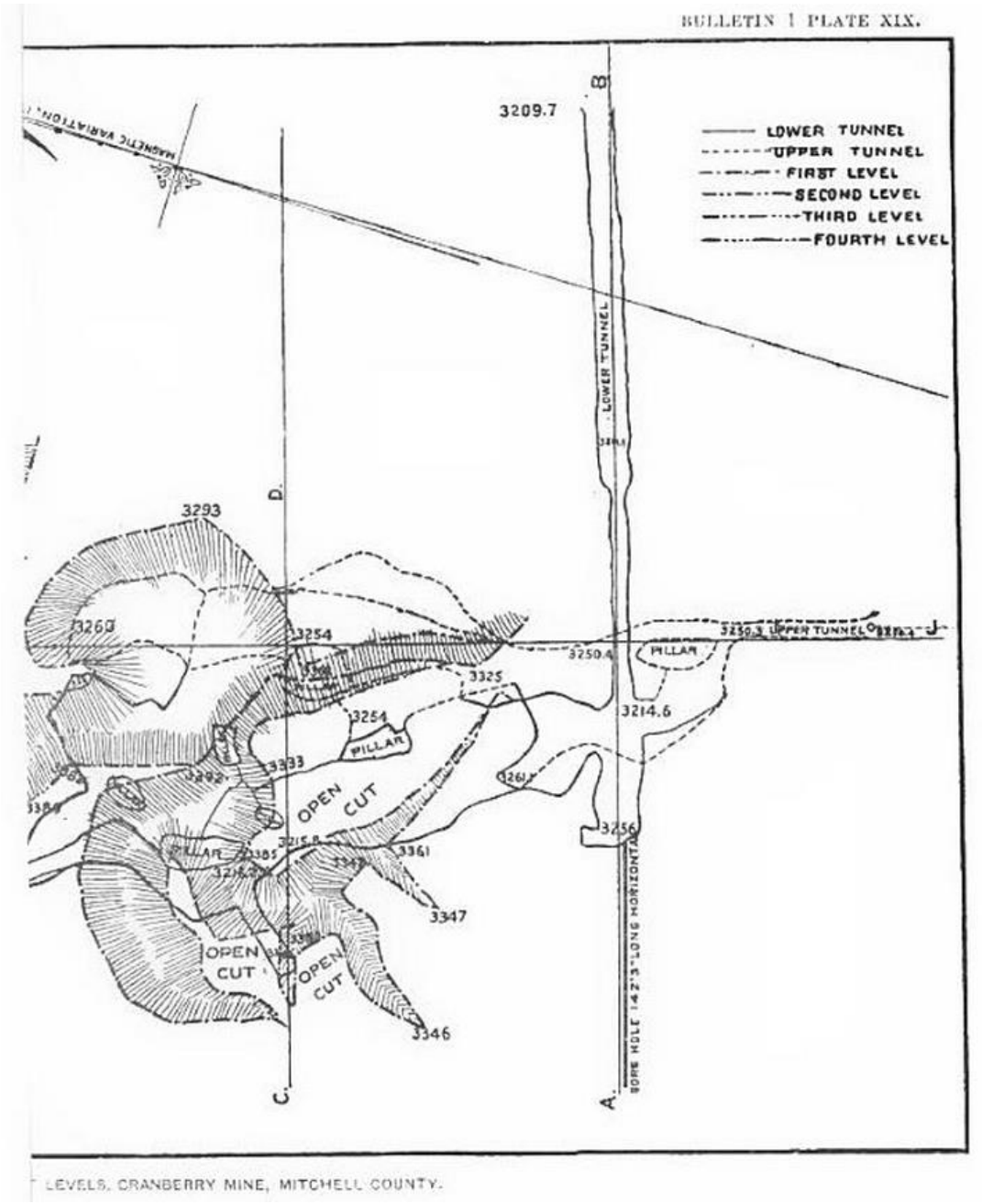
LEVYTYPE CO. PHILA



Cranberry Mine, Vertical Section Through I-J of Pate XIX.



Cranberry Mine, Vertical Sections Through G-H, E-F, C-D, and A-B of Plate XIX.



LEVELS, CRANBERRY MINE, MITCHELL COUNTY.

Since 1884, 202,850 tons of marketable ore (averaging probably from 40 to 50 per cent metallic iron) have been mined here, which, on the above assumption (and estimating the waste to be about the same), would leave 4,394,300 tons of ore material in sight at present. It is not intended to make this an absolute estimate, but it is supposed to be approximate and conservatively safe; nor does it take in the entire area explored on the Cranberry Iron and Coal Company's property, for, by reference to Plate XVI it will be seen that the outcrop has been opened by pits on Little Fork mountain, 950 feet S. 36° E. from the mouth of the upper tunnel, and on Cranberry ridge, 450 feet N. 33° W. from the upper end of the fourth level opencut, and even beyond this to the Tennessee line, but present developments do not furnish sufficient data on which to base an estimate…"

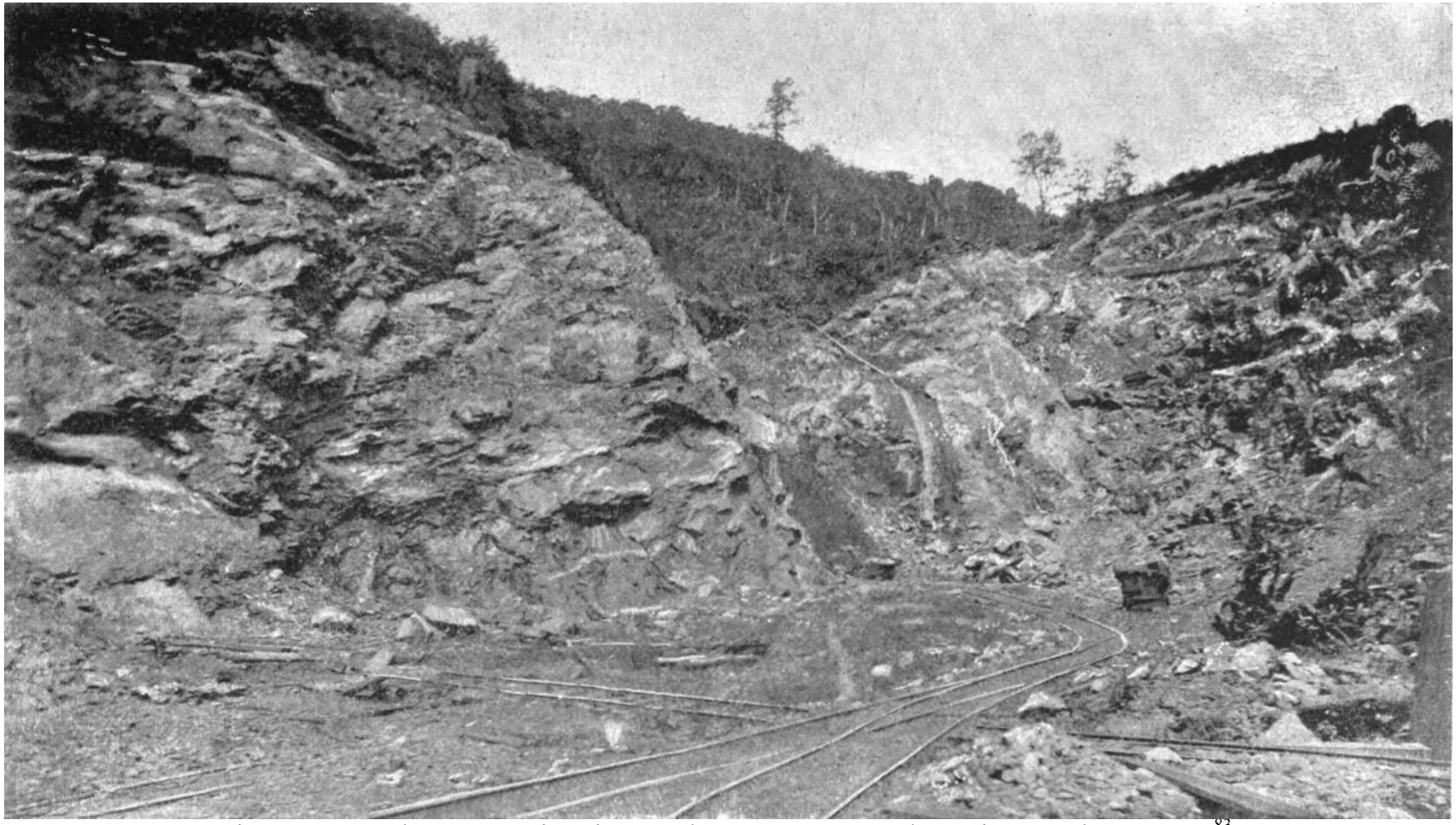


Figure 33. “Cranberry Iron Mine First Level Opencut, At Tunnel Opening; Cranberry, N.C.”[83]

"At the time the mine was last visited, in July, 1892, mining was prosecuted only in the second and third level opencuts, and in the small openings on the west flank of the hill, above the tunnel workings, the chief aim being to develop the deposit by stripping and uncovering new portions.

The output averaged about 40 tons per day, just sufficient to supply the small furnace. In mining, large masses of ore and rock are broken down by air-drilling and blasting. The dead rock and very lean ore are loaded on tram-cars, drawn by mules, and dumped over the waste piles. The remainder is counted as ore, and is conveyed by means of a long wooden chute to the ore platforms at the foot of the hill, alongside of the railroad tracks. Some of this is practically pure magnetite, much of it is fairly clean ore, and naturally much of it is lean ore in which the gangue predominates.

For shipping purposes this ore is again hand-picked, and loaded by hand and shovel on the railroad cars alongside the platforms, when it is ready for transportation to Johnson City, Tenn. Here it is discharged on platforms, and reloaded on the standard gauge cars of the East Tennessee, Virginia and Georgia railroad, all by hand and shovel.

The average cost of mining and putting f.o.b. railroad cars at the mine is estimated at $1.20 a ton; the average miner's wages are 80 cents per day; the average value of the shipping ore at the mine is $1.40 per ton; freight to Johnson City, Tenn., from mine is 70 cents per ton."

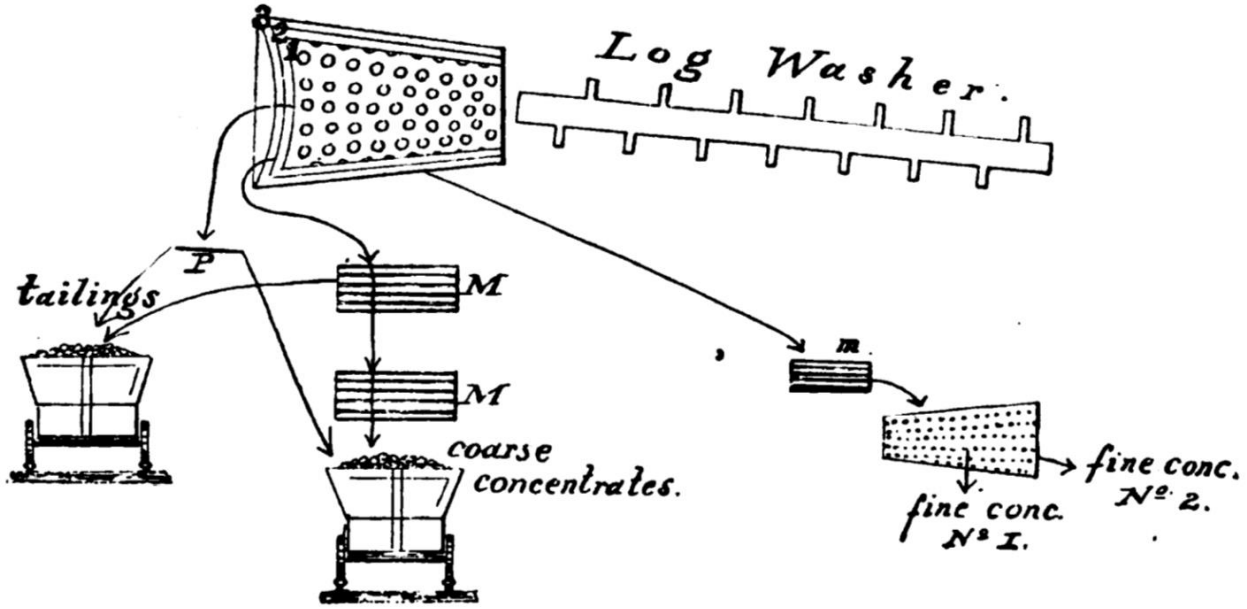


Figure 34 "Showing method of magnetic concentration, Cranberry mine."

"At present, all ore going to the furnace is treated by magnetic concentration without previous hand-picking; and the waste-piles, which have accumulated in large quantity during the past years, are now being culled over and similarly treated.

For this purpose the ore is loaded from the platforms at the base of the hill on the railroad cars, which are shifted to the crusher; in a similar way the lean ore from the waste-piles is transferred to the crusher. The material is there unloaded and fed by hand and shovel into a Blake crusher, run by steam; it is reduced to a two-inch size, and discharged directly into tram-cars which run to the concentrator (see Plate XVI). The concentrating plant consists of a three-story mill, the general arrangement of which is shown in Fig. [34].

The material is fed by a hopper into a log washer (improved pattern, steel shaft and teeth), at the upper end of which it discharges into triple cylinder revolving screens, perforated with circular holes:

No. 1, inside cylinder; diameter of holes – 2 inches.
No. 2, middle cylinder; diameter of holes – 1½ inches.
No. 3, outside cylinder; diameter of holes – ¼ inch.

The material that passes over the two-inch screen goes to a picking table (P) where it is hand-sorted, the ore and deads being separated and going to the respective cars as shown.

That passing over the 1½ and ¼-inch holes goes to a double set of revolving magnets (MM) of the Venström [Wenström] pattern, placed under each other, and fed with fine sprays of water.

The coarse concentrates (from ¼ to 2-inch size) from these magnets drop into the ore car placed immediately below, while the deads or tailings are carried off on a conveyor belt to another car as shown.

All that passes through the ¼-inch holes of the outside cylinder is washed by a stream of water to a separate revolving magnet (m), of a pattern designed and put up by the company, the concentrates from which pass through a revolving screen of 10 meshes to the square inch, and are separated into two sizes, fine concentrates No. 1, passing over, and fine concentrates No. 2, passing through the screen.

The cost of magnetic concentration is put at about 40 cents per ton of concentrates, exclusive of the cost of running and maintenance of the dynamo.

The coarse concentrates are separated into two sizes in the stockhouse by passing over 7/8-inch iron screen bars. The fine concentrates are dried by exposure to the air in open bins…

The usual furnace charge consists of two parts of lump (passing over 7/8-inch screen-bars), one of screen ore (passing through 7/8-inch bars), and one of No. 1 fine concentrates; or two of lump, two of screened ore, and one of No. 2 fine concentrates.

The proportionate charge of ore, fuel and limestone to the ton of iron produced was, for one week's run in June, 1892, ore 2 tons, coke 1.09 tons, limestone 1.02 tons. Limestone is brought from Watauga Point, Carter county, Tenn…

Until the last few years the furnace was run on charcoal; at present coke is brought from Pocahontas, Va., at a cost of $3.20 per ton, delivered at Johnson City…

The temperature of the blast is 800°; average pressure 2 3/8 lbs. The furnace is tapped every six hours, running from 3½ to 4 tons of pig iron…

This iron is valued at $16.00 per ton at the furnace, and is shipped to furnaces and steel works in Ohio, Pittsburgh, Pa., Bethlehem, Pa., etc. Much of it is used in the manufacture of crucible tool steel.

The annual production of ore and pig iron (since 1884) at the Cranberry mines and furnace, is tabulated below:

Annual Production of Iron Ore at the Cranberry Mine, Mitchell County,
In Gross Tons (2240 lbs.)

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
3,998	17,839	24,106	45,032	15,705	19,819	30,290	27,628	18,433

These figures show notable fluctuations, due to the condition of the market and the varying demand for the ore. From 1884 to 1888 there was a rapid increase; in 1888 there was a

sudden falling-off of over 65%; in 1890 it had gradually increased to nearly double the production in 1888; from 1890 to 1893 there has been a gradual decrease of nearly 40%.

Of the above amounts, the following shipments were made, chiefly to Alabama, Tennessee and Virginia furnaces:

Shipments of Iron Ore from the Cranberry Mine. Mitchell County,
In Gross Tons (2240 lbs.)

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
not known				10,129	12,974	22,873	20,284	12,088

Total Production of Pig Iron at the Cranberry Furnace, In Gross Tons.

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
388	1598	1964	3250	2143	2587	2840	3217	2902

Similar fluctuations to those of the ore production are observed here; but the decrease in 1888 was only 34% as against 65% in the ore, due probably to the fact that the proportion of ore shipped was less, and the grade of the product higher in metallic iron; in 1890 again the increase was not commensurate with that of the ore production, probably due to reasons the reverse of the above; instead of decreasing in 1891 there was an increase of 13%, which must have been due to the higher grade of the ore product for that year, as the decrease in ore shipments is nearly proportional to that in the total ore production; in 1892 there was a slight decrease below that of 1891 in the pig iron output, but it was still above that for 1890, in contradistinction to the ore output, for similar reasons to those elucidated.

Until the year 1890 the total output of the furnace was charcoal iron; since then it has been running at intervals on coke and charcoal separately, as follows:

	1890.	1891.	1892.
Charcoal pig iron (gross tons)	2325	467	313
Coke pig iron [(gross tons)]	515	2750	2589

The possibilities of the Cranberry mine as an iron-ore producer have never been fairly demonstrated. As already mentioned, the policy has been rather to develop the magnitude of the deposit by slow exploratory work, than by energetic endeavors to combine that very important feature with a larger output. There is no reason why this should not be made a large and steady producing iron ore mine. By this no reflection is intended against the present management, as there may be potent and private reasons for continuing in the present way, amongst others the present general depression in the iron industry. The company is certainly looking to the introduction of wise and beneficial improvements, such as magnetic concentration of the ore, etc. But the methods of mining, particularly in the handling of the product, are too evidently susceptible of many economic improvements by which the cost of the output should be materially reduced. Operations on a large scale will also tend to reduce this cost.

Even with the comparatively great cost of coke at the works, it seems more profitable to smelt this ore into pig-iron at the mine than to ship it for that purpose, and it is hoped that in the near future equally good coke can be had from the Big Stone Gap region in southwest Virginia, 110 miles nearer than the present supply from Pocahontas…"[84]

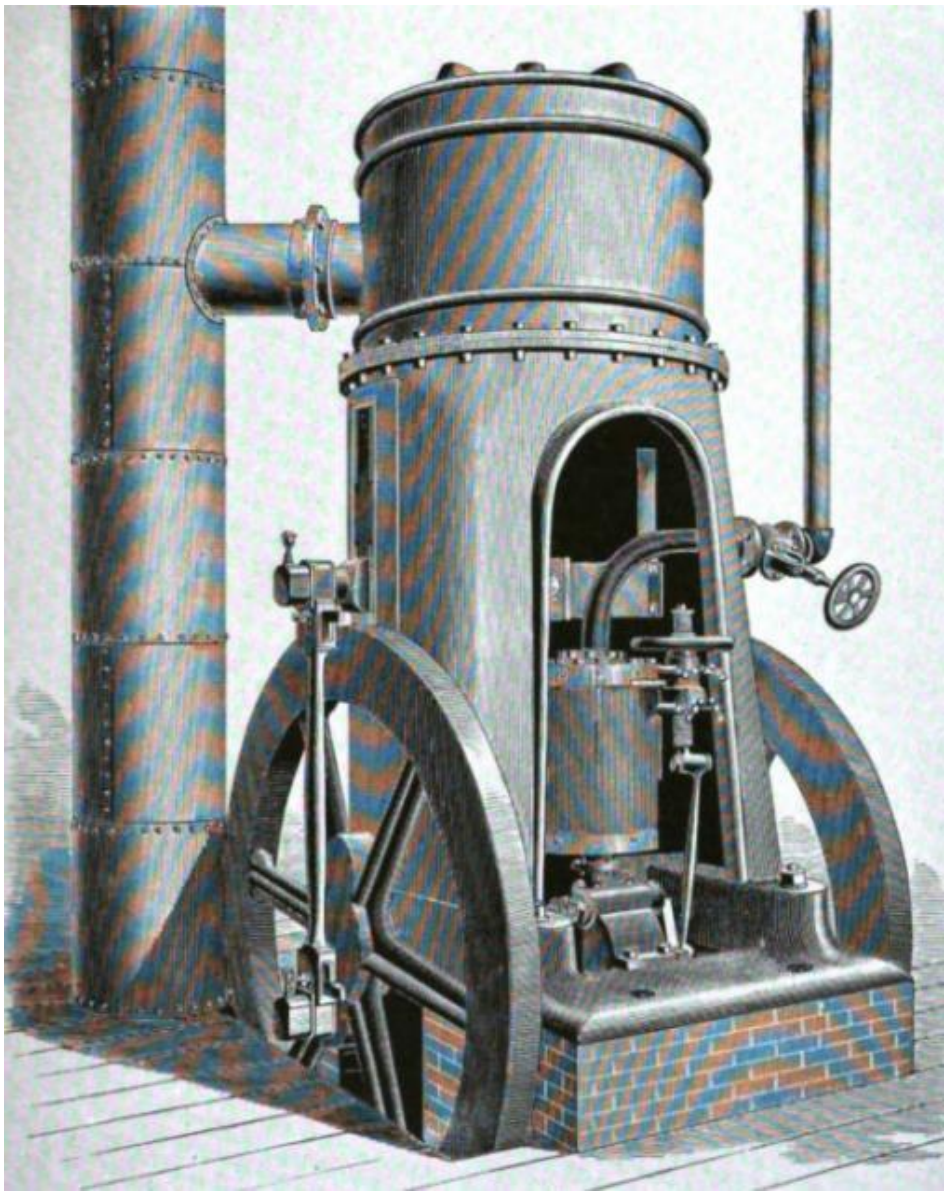


Figure 35. Example of "A Bull Type of Blowing Engine, Built by Weimer Machine Works Co., Lebanon, Pa."[85]

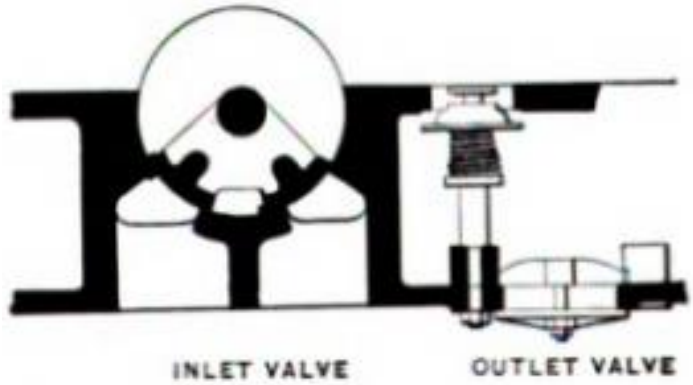


Figure 36. "Air Valves of the Philadelphia Engineering Works Engine."[86]

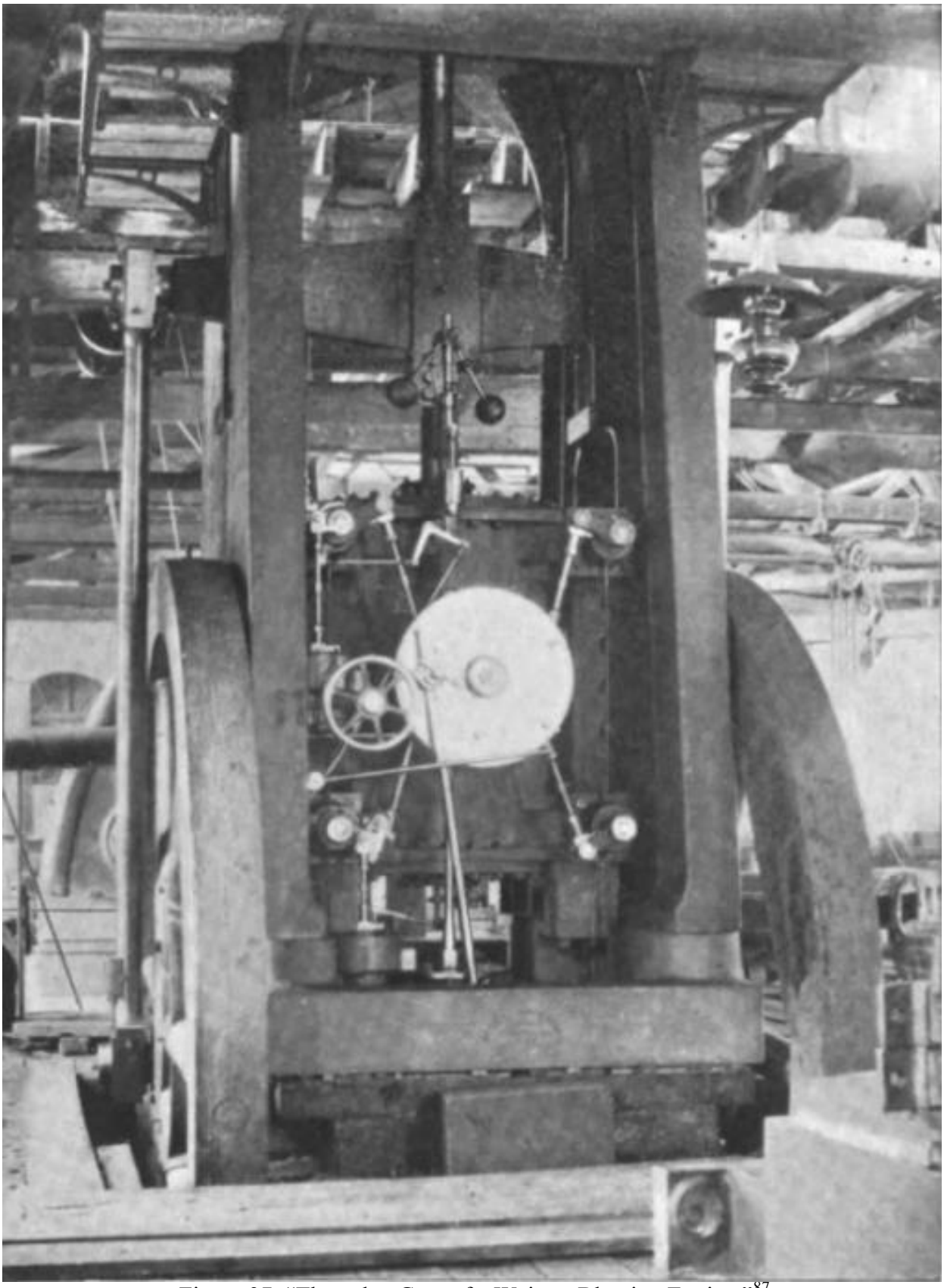


Figure 37. “The valve Gear of a Weimer Blowing Engine.”[87]

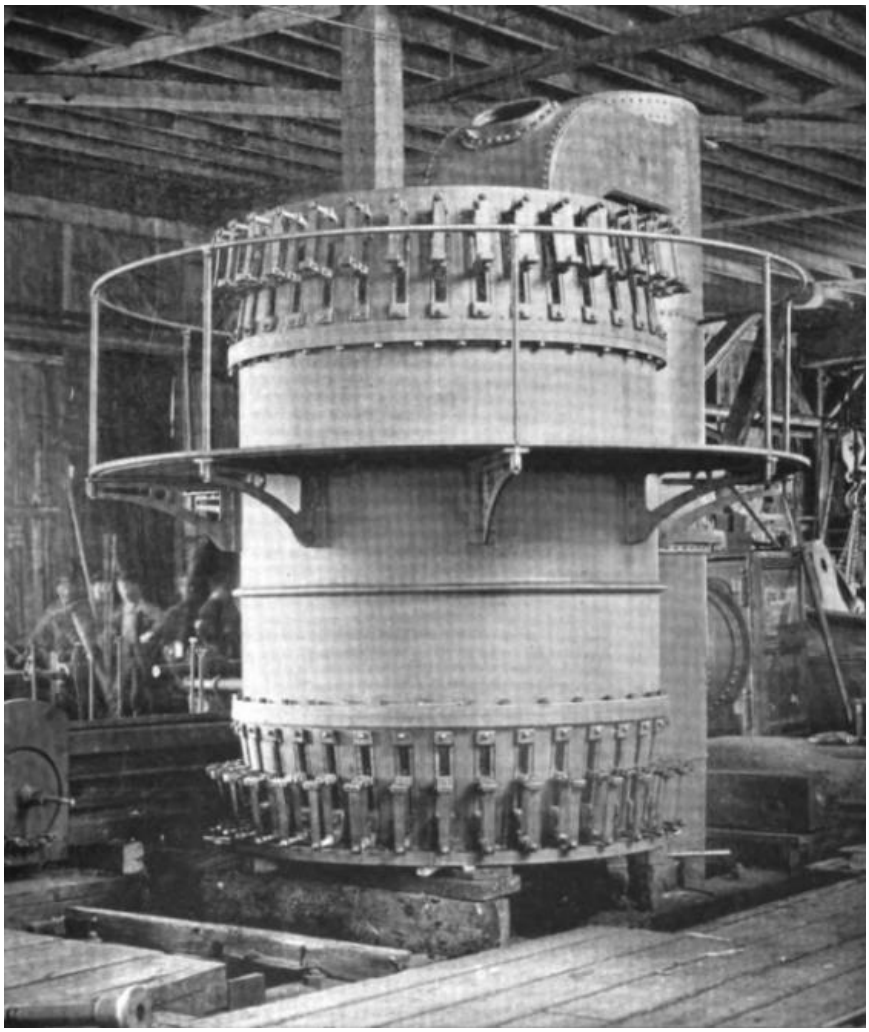


Figure 38. "A Weimer Blowing Cylinder, Showing the Receiving Valves."[88]

"A radical departure was introduced in 1876 by a blowing engine built by the Weimer Machine Works, of Lebanon, Pa., shown in motion at the Centennial Exposition at Philadelphia in that year. By reason of the valve arrangement this engine was able to run at speeds which up to that time had been considered as impracticable. This exposition engine, which is still in use, has a steam cylinder 20 inches in diameter, a blowing cylinder 48 inches in diameter, and a stroke of 24 inches…"[89]

"Other illustrations of a Weimar blowing-engine have also been published ["Iron Trade Review, vol. xxx. No. 4, pp. 8-9"]. It has a 42-inch steam-cylinder and 84-inch air-cylinder, with a stroke of 60 inches. At 45 revolutions and 20 lbs. of air-pressure it delivers 17,000 cubic feet per minute. The valves are placed round each end of the cylinder…"[90]

"The Blake Breaker, as finally adopted by its inventor, Mr. Eli Whitney Blake, was the first successful jaw breaker, and it has held its place as the standard machine ever since. The original form, patented June 15, 1858…"[91]

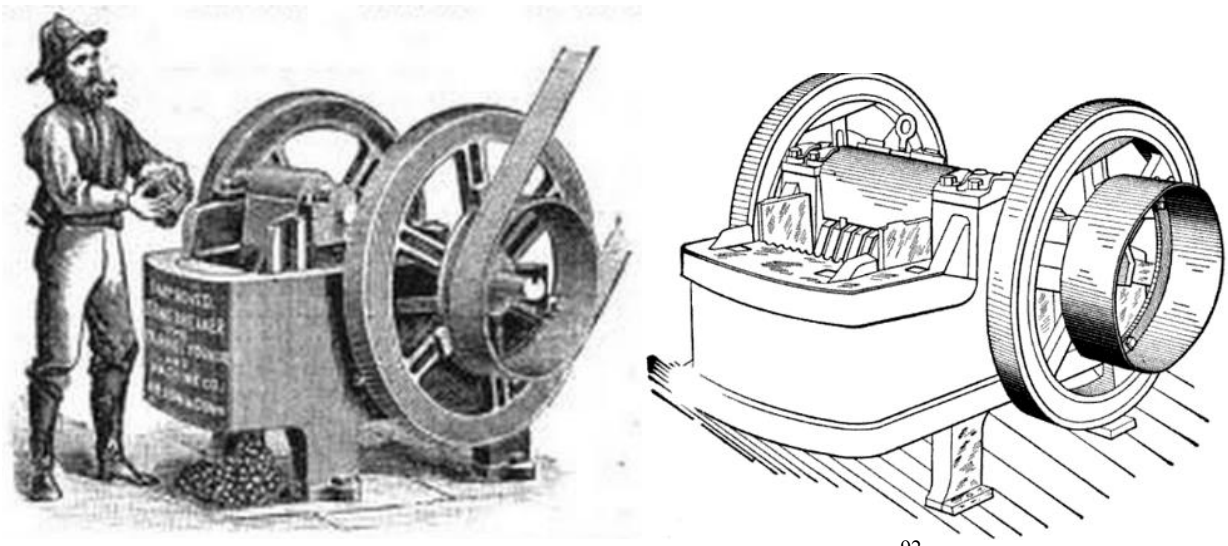


Figure 39. Examples of a Blake Ore Crusher[92]

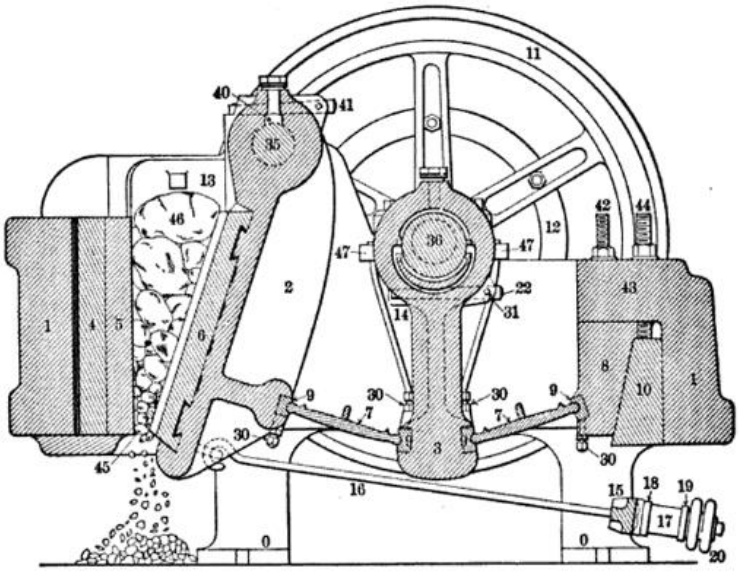


FIG. 5.—SECTION OF BLAKE BREAKER, MADE BY THE FARREL FOUNDRY AND MACHINE CO.

KEY TO FIGS. 5, 6 AND 7.

0. Legs.
1. Frame.
2. Swing jaw.
3. Pitman.
4. Fixed jaw.
5. " " plate.
6. Swing " "
7. Toggle.
8. " block.
9. " bearing.
10. Wedge.
11. Fly-wheel.
12. Pulley.
13. Cheek plate.
14. Pitman half-box.
15. Spring bar.
16. " rod.
17. Rubber spring.
18. Washer.
19. "
20. Thumb nut.
21. Hopper.
22. Key.
23. Bolt.
24. "
25. "
26. Eye bolt.
27. Lock wrench.
28. " "
29. Bolt.
30. "
31. Set screw, for key.
32. Bolt.
33. Set screw.
34. Nut.
35. Swing jaw shaft.
36. Eccentric shaft.
37. Cap for swing jaw shaft.
38. " " eccentric.
39. Key for fly-wheel.
40. Gib.
41. Key.
42. Supporting bolt.
43. Web.
44. Adjusting bolt.
45. Throat.
46. Mouth.
47. Oil tubes.
48. Recesses for cheek plates.

Figure 40. "Section of Blake Breaker"

1892. "Statistics of the Mineral Products of North Carolina for 1892," by H.B.C. Nitze.

"Pig Iron.

There was but one blast furnace in active operation in the State, namely, that at Cranberry, Mitchell county, belonging to the Cranberry Iron and Coal Company. This is a small brick stack of the following dimensions: Height 50 feet, diameter of bosh 10 feet 2 inches, diameter of hearth 3 feet, capacity 14 to 15 tons per day. It uses the low phosphorus magnetic ore of the Cranberry mine situated close by, magnesian limestone from Carter county, Tenn., and coke from Pocahontas, W. Va.

The total output of this furnace for 1892 was 2,902 gross tons, of which 313 tons were charcoal and 2,589 tons coke iron; the total product was valued at $52,000 at the furnace.

The quality of this product was a special Bessemer iron, averaging less than 1.00 per cent, silicon, and less than 0.025 Per cent, phosphorus. It was shipped to steel works in Ohio and Pennsylvania.

The total production in gross tons (22,401 pounds) of the Cranberry furnace for the past nine years is shown in the following table:

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
388	1,598	1,964	3,250	2,143	2,587	2,840	3,217	2,902

…

Iron Ore.

The total production of iron ore during 1892 is estimated at 23,433 gross tons, valued at $43,306.20 at the mines. Of this amount 17,088 gross tons, valued at $34,423.20, were shipped out of the State; the balance was turned into 2,902 gross tons of pig metal.

The only two mines in operation were the Cranberry mine in Mitchell and the Ormond mine in Gaston county.

The Cranberry Mine, operated by the Cranberry Iron and Coal Company, produced 18,433 gross tons, valued at $25,806.20 at the mines. Of this amount 12,088 tons, valued at $16,923.20, were shipped to furnaces in Southwest Virginia.

The ore is a magnetite, of which the following analysis by Mr. Porter W. Shimer shows the quality of the run of mine:

	Per Cent.
Silica	27.73
Metallic iron	45.90
Metallic maganese	0.44
Alumina	1.01
Lime	9.69
Magnesia	1.51
Sulphur	0.012
Phosphorus	0.007

The total output of the Cranberry mine in gross tons for the past nine years is shown in the following table:

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
3,998	17,839	24,106	45,032	15,705	19,819	30,290	27,628	18,433

The Ormond Mine…"[93]

20 October 1892. Chicago Journal of Commerce and Metal Industries.

"Work has been commenced by the East Tennessee, Virginia & Georgia railroad on the side tracks for the Carnegie Furnace at Johnson City, Tenn., and it is stated that the furnace will soon go into blast, as one of the promoters of the enterprise has raised $100,000 for working capital."[94]

1889 – 1893. "Cranberry, North Carolina," by John R. Waite.

"Charcoal was an expensive fuel, so in 1889 the company experimented with coke from Virginia's Pocahontas coal field. The trial was successful and by 1893 coke was the only fuel used at Cranberry. The furnace was rebuilt to accommodate the change in fuel. Improvements were made in the inclined plane used to load the furnace, the furnace was relined with 14" brick creating an 11"6' bosh, and the exterior of the furnace was faced with 12" red brick."[95]

1892. Directory to the Iron and Steel Works of the United States.

"Tennessee. Coke.

Carnegie Iron Company, Johnson City, Washington county. Building one stack, 75 x 16; nearly completed; three Whitwell stoves, each 65 x 18; will use Pocahontas coke and Cranberry ore; product to be 'special Bessemer' pig iron; annual capacity, 40,000 net tons. J.T. Wilder, President; J.W. Cure, Secretary and Treasurer; H.W. Hargreaves, Superintendent…

North Carolina. Coke.

Cranberry Furnace, Cranberry Iron and Coal Company, Cranberry, Mitchell county. Philadelphia office, 240 South Third st. One stack, 50 x 11, built in 1883-4, and first put in blast April 16, 1884; hot and cold blast; fuel, coke, formerly charcoal; ore, magnetic, mined on the property; product, pig iron of Bessemer quality; annual capacity, 6,000 net tons. Brand, 'Cranberry.' Frank Firmstone, President; J.S. Wise, Secretary and Treasurer; C.H. Nimson, General Manager."[96]

1892. Philadelphia Securities…[97]

"Cranberry Iron and Coal Co., 240 S. 3d st. General and Corporate Office, Cranberry, Mitchell Co., N.C. Inc. Feb. 28, 1873, in North Carolina. Charter Perpetual. Transfer Office, 240 S. 3d st. Object – Mining of coal and iron ores, and manufacturing of pig iron. Plant located at Cranberry, N.C. One blast furnace, built in 1883-4, first blown in Apr. 16, 1884. Annual capacity, 6,000 net tons. Capital not stated. Annual Meeting, 3d Tues. in Feb., at 240 S. 3d st. Fiscal year ends Dec. 31. Dividends not stated. No funded debt. Officers – Frank Firmstone, President; John L. Wise, Secretary and Treasurer; C. H. Nimson, General Manager. Directors – Ario Pardee, Ario Pardee, Jr., R.F. Hoke, Geo. Richards, Frank Firmstone, John R. Fell, Charles L. Peirson."

15 April 1893. "Minerals Products of North Carolina…

Pig Iron—Only one blast furnace was in operation during 1892, that at Cranberry, Mitchell County, belonging to the Cranberry Iron and Coal Company. It is a brick stack; height,

50 ft.; bosh, 10 ft. 2 in.; hearth, 3 ft.; capacity, 15 tons per day. It uses the low phosphorus magnetic ore of the Cranberry mine, magnesian limestone from Carter County, Tenn., and Pocahontas coke. The total output in 1802 was 2,902 tons, of which 313 tons were charcoal and 2,589 tons coke pig; value of product, $62,000. The iron is special Bessemer, averaging less than 1.00%, silicon and less than 0.025% phosphorus. It was shipped to steel works in Ohio and Pennsylvania. The production of the Cranberry furnace has been as follows in gross tons: 1890, 2,840; 1891, 3,217; 1892, 2,902; total, from 1884 to 1892, inclusive, 20,891 tons…

Iron Ore—The total production of iron ore in 1892 is estimated at 23,433 gross tons, valued at $43,306. Of this amount 17,088 tons, valued at $34,423 were shipped out of the State. The only mines in operation were the Cranberry, in Mitchell County, and the Ormond, in Gaston County. The Cranberry mine produced 18,435 gross tons, valued at $25,806, shipping 12,088 tons, valued at $16,923 to furnaces in Southwest Virginia. The ore is magnetite, the following analyses by Porter W. Shimer showing the average quality of run of mine: Silica, 23.72%; metallic iron, 45.90%; metallic manganese, 0.44%; alumina, 1.01%; lime, 9.09%; magnesia, 1.51%; sulphur, 0.012%; phosphorus, 0.007%.

The total output of the Cranberry mines has been as follows, in gross tons: 1890, 30,290; 1891, 27,628; 1892, 18,438; total, 9 years, 1884 to 1892 inclusive, 202,850 tons…"[98]

1 July 1893. Richmond Dispatch.

"Raleigh, N.C., June 30… The well-known iron furnace at the Cranberry mines closed to-day. This throws many people in Mitchell county out of employment. The mines also shut down and only one train will be run on the company's railway between Cranberry and Johnson City."

9 August 1893. Herald and Tribune.

"The Cranberry Iron Works have suspended since our last issue, because they could no longer find sale for their products. If the fear of free trade has such an effect, what would be the reality."

1893. Philadelphia Securities…[99]

"Cranberry Iron and Coal Co., 240 S. 3d st. Gen'l and Corporate Office, Cranberry, Mitchell Co., N.C. Inc. Feb. 28, 1873, in N.C. Charter Perp'l. Transfer Office, 240 S. 3d st. Mining coal and iron ores, and manufacturing pig-iron. Plant at Cranberry, N.C.; one blast furnace built 1883-4, first blown in Apr. 16, 1884. Annual capacity, 6,000 net tons. Capital not stated. Fiscal year ends Dec. 31. Dividends not stated. No funded debt. Frank Firmstone, Prest.; John S. Wise, Secy and Treas; C.H. Nimson, Gen'l Mgr. Directors – Ario Pardee, Jr., R.F. Hoke, Geo. Richards, Frank Firmstone, John R. Fell, Charles L. Peirson."

1893 – 1894. "Cranberry, North Carolina," by John R. Waite.

"The financial panic of 1893 and a glut of iron, caused by the opening of the Mesabi iron region of Minnesota, dealt a severe blow to CI&C. While the Board of Directors tried to find a solution to the company's financial problems, the mines sat idle.

Through much of 1893, and all of 1894, no iron was mined at Cranberry… Throughout the 1890s the company had the Cranberry operations up for sale; but no buyers were found."[100]

3 March 1894. The Engineering and Mining Journal.

"North Carolina… Mitchell County. Cranberry Iron and Coal Company. – During the year 1893 this company mined 9,482 tons (of 2,240 lbs.) of iron ore (magnetite), of which 6,298 tons were used in its furnace. The output of the furnace was 2,789 tons of Bessemer pig iron."[101]

26 May 1894. "North Carolina Iron Ores and Magnetic Concentration. Written for the Engineering and Mining Journal by Dr. W.B. Phillips.

In a bulletin recently issued by the Geological Survey of North Carolina, Mr. H.B.C. Nitze, Assistant State Geologist, has given us an interesting account of the iron ore deposits of that State… The North Carolina Steel and Iron Company has a good furnace at Greensboro, built in 1892, with a calculated capacity of 100 tons per day, for using the brown ore of Ore Hill in Chatham County, and possibly the magnetite of Stokes and near-by counties, but it has never gone into blast. This furnace, with the little 15-ton furnace at Cranberry, Mitchell County, upholds the dignity of the iron production of the State. The total output of ore in 1892 was about 24,000 tons, of which something over 18,000 tons came from Cranberry, and 5,000 tons from the Ormond mine in Gaston County. The total production of pig iron in 1892 was 2,589 gross tons of coke iron, high-grade Bessemer, and 312 gross tons of charcoal iron, all made at Cranberry…

The Wenstrom magnetic separator has done excellent work at Cranberry, and there is no reason why the magnetites of the same general belt should not come into use as high-grade Bessemer ores. Whether or no a mine can afford to concentrate all of its ore is as yet an unsettled question, but now that 'fines' have proved their adaptability for furnace work, one of the chief obstacles in the way has been removed. There are many first-rate water-powers in the western iron ore region, some of them within easy distance of known deposits, which could be utilized for the generation and transmission of the electric current, for drilling, haulage, crushing and concentration. In a series of 22 analyses of Cranberry coke iron, made by Porter W. Shimer, the highest phosphorus given was 0.030%, and the highest sulphur 0.067%. No better evidence of the quality of some of the magnetites of the western belt can be afforded..."[102]

1894. Directory of the Iron and Steel Works of the United States and Canada.
"Tennessee. Coke.

Carnegie Iron Company, Johnson City, Washington county. One stack, 75 X 16; nearly completed; work suspended in 1892; three Whitwell stoves, each 65 x 18; will use Pocahontas coke and Cranberry ore; product to be 'special Bessemer' pig iron; annual capacity, 36,000 gross tons. J.T. Wilder, President; J.W. Cure, Secretary and Treasurer; H.W. Hargreaves, Superintendent…

North Carolina. Coke.

Carolina Furnace, The North Carolina Steel and Iron Company, Greensboro, Guilford county…

Cranberry Furnace, Cranberry Iron and Coal Company, Cranberry, Mitchell county. Philadelphia office, 240 South Third st. One stack, 50 x 11½, built in 1883—4, and first put in blast April 16, 1884; hot and cold blast; fuel, coke, but formerly used charcoal; ore, magnetic, mined on the company's property; product, pig iron of Bessemer quality; annual capacity, 5,200 gross tons. Brand, 'Cranberry.' Frank Firmstone, President; J.S. Wise, Secretary and Treasurer; C.H. Nimson, General Manager. Selling agents, Matthew Addy & Co., Cincinnati.

Number of furnaces in North Carolina: 2 coke stacks."[103]

1894. The Concentration and Sizing of Crushed Minerals.

"…The second was the Wenstrom separator, which was at work in the Cranberry ironworks in North Carolina. The iron ore had been previously roasted and crushed, and was being supplied to the machine in sizes about equal to walnuts. A broad stream of this fell down through the magnetic field just above a plate provided with a knife-edge top, and placed in such a way that the non-magnetic parts fell on the one side, whilst those which were attracted by the electro-magnets were diverted and made to fall on the other side."[104]

Figure 42. "Ore pits at Cranberry, Avery County, North Carolina" by John Karl Hillers. The photograph was apparently accepted in December 1894.[105]

Figure 43. "One of the ore pits at Cranberry iron mines.
Avery County, North Carolina. ca. 1894" by John Karl Hillers. The photograph was apparently accepted in December 1894.[106]

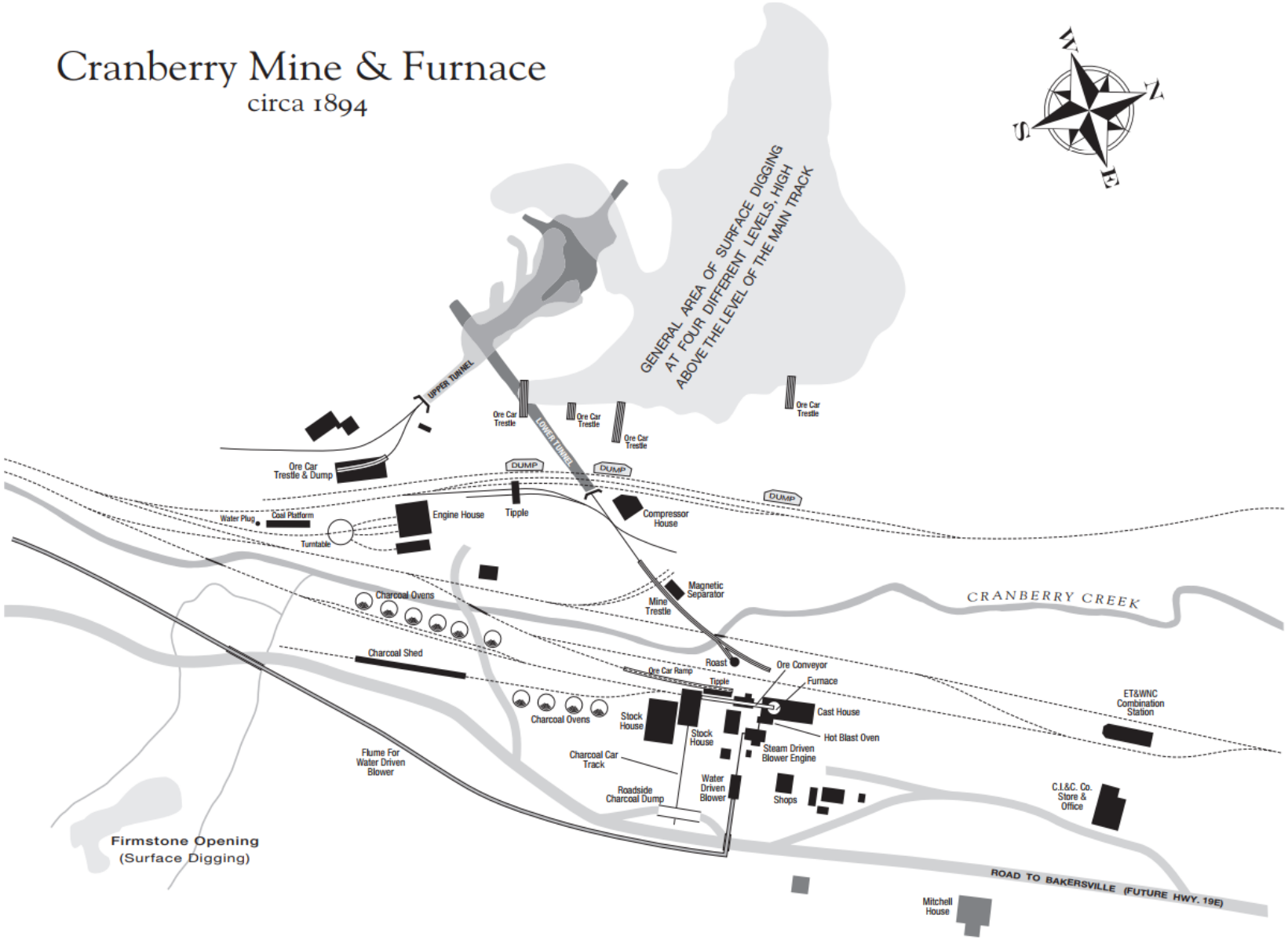


Figure 41. Cranberry circa 1894, by Chris Ford.[107]

30 August 1895. The Bolivar Bulletin.

"Furnace to Start Up. Johnson City, Tenn., Aug. 26. – Men will be put to work in the Cranberry mines in a few days to mine ore sufficient to start the blast furnace at that place. When the furnace starts another train will be put on the Narrow Gauge between this place and Cranberry."

Summer 1895. "Cranberry, North Carolina," by John R. Waite.

"When iron prices finally rose during the summer of 1895, the company decided to resume production. But iron markets remained weak..."[108]

5 September 1895. The Johnson City Comet.

"Frank Firmstone, of Philadelphia, president of the Cranberry Iron and Coal Company, passed through the city yesterday on his way to Cranberry. There are strong indications that the furnace will be put into blast at once and it is believed that Mr. Firmstone's visit is for that purpose. He had nothing to say, however, for publication."

12 September 1895. Watauga Democrat.

"News reaches us that the Cranberry Iron and Coal Co. at Cranberry, is making preparations to resume work at once. If this be true, it will be a great help to the laboring classes in this and surrounding counties.'

21 September 1895. Engineering and Mining Journal.

"Mitchell County. The Cranberry magnetic iron ore mines, which have been idle for two years past, are now being put in order to begin work it is said with about 300 men, some contracts for the ore having been made."[109]

11 October 1895. American Manufacturer and Iron World.

"The furnace at Cranberry, N.C., will be blown in at an early date and it is understood that the Carnegie furnace at Johnson City, Tenn., has been ordered sold, and prospects are that with a sale it will be put in blast."[110]

15 October 1895. The Progressive Farmer.

"Winston Sentinel: There are at present about 300 men engaged in preparing the Cranberry Mine in Mitchell county for the resumption of active work. Experts say that 400,000 tons of ore are in sight. A thousand tons a day can be taken out.'

17 October 1895. Engineering News and American Railway Journal.

"Blast Furnaces… the furnace at Cranberry, N.C., will be blown in at an early date. The Carnegie furnace at Johnson City, Tenn., has been ordered sold."[111]

October 1895. "Southern Magnetites and Magnetic Separation," by Harvey S. Chase.

"… Experiments have been carried on, however, upon a practical scale in separating these ores magnetically, at the well-known Cranberry mines, in Mitchell county, N.C., with results which are encouraging…

The experience with magnetic separation at Cranberry is noteworthy in this particular. Here we have an excellent Bessemer ore, non-titaniferous, comparatively cheaply mined, partly in open cut and partly in tunnel, with good transportation-facilities, and with a 'run-of-mine' averaging about 42 to 43 per cent. of metallic iron. The greater portion of this iron is in magnetic oxide, Fe_3O_4 but from 5 to 11 per cent. is present as FeO in hornblende. Should the total output be crushed and magnetically separated, this FeO would be lost in the tails, and it becomes a question of considerable importance to decide when to save the hornblende and when to sacrifice it, since within these percentages of iron the margin of profit—taking wear and tear of machinery into consideration—may be located.

With the recent marked revival in the iron-trade, the question of profitably producing Bessemer pig with ores from the Cranberry district and coke from southwest Virginia, has once more assumed importance, and the element which will be found decisive in this matter (assuming that the coking-coals of Big Stone Gap are satisfactory, and that the necessary railroad-extensions will be made) is magnetic separation.

It is therefore interesting to examine the result of the experiments made at Cranberry, in 1892 and 1893, under the direction of Mr. Frank Firmstone, to whom I am indebted for the data here given.

As Mr. Firmstone's object in these tests was wholly a practical one, namely, to procure ore for the furnace at Cranberry from material which otherwise would have been thrown on the waste-dump, and to do this at a cost not greater than that of mining an equal amount of new ore, he did not attempt to particularize the various elements of cost of crushing, washing, screening, and separating; and he expressly states that too great dependence should not be placed upon the tabulation of his results, as the practical running was for a comparatively short time and with crude and insufficient machinery. Nevertheless, the results attained are distinctly encouraging, and certain deductions may obviously be drawn.

The total cost of Mr. Firmstone's treatment of the waste ore averaged about 45 cents per ton of concentrates obtained, part of which carried 63 per cent. of metallic iron, and the average about 47 per cent., while the cost of mining an equivalent amount of new ore would have been at least 70 cents per ton. This cost of 45 cents per ton for cobbing, crushing, washing, screening and separating, covers all labor and materials, including repairs, except cost of power, which was derived from the furnace-boilers, and was nominal.

This cost, Mr. Firmstone says, could certainly be reduced one-half with a larger plant and improved machinery; and, making due allowance for power, we may consider 25 cents per ton as a safe figure for the cost of this separation per ton of concentrates produced; the cost of mining, of course, being charged against the shipping ore, and the material used for separation being considered as otherwise a waste product.

The question of importance then appears to be whether fine crushing shall be attempted, with the accompanying advantage of the higher grade of concentrate produced, but at greatly increased cost for power, for repairs and renewals, for fine screens and for comparatively delicate and discriminating magnetic separators (like the well-known Ball-Norton or the Chase machine, described before the Institute meeting at Plattsburg in 1892 [Trans, xix., 187, and xxi,

503.]), and with the production of a fine-grained furnace-burden and the necessarily large loss of iron as FeO in the tails.

This question is fundamental; and the experience with the Cranberry ores, while perhaps not decisive, strongly points in favor of a minimum of crushing and a maximum of coarse ore, even though it be of lower percentage of iron.

The ore at Cranberry, before shipping, is passed over bar-screens having 1½-inch openings, and what goes through, along with any clay from the open cuts which shows much ore in small pieces, is washed in a log-washer, in which it is freed from clay and very fine rock. A revolving screen on the washer-shaft separates the washed stuff into four sizes, viz.: (1) coarser than 1¾-inch round hole, which is hand-picked; (2) between 1¾ and 1¼-inch round; (3) between 1¼ and 3/16-inch round, which two sizes are treated separately on two Wenström separators; and (4) finer than 3/16-inch round, which is washed by a stream of water to a revolving magnet. The heads from this magnet are again divided by a revolving screen (8 holes per inch, of No. 18 wire); the rejections, called "shot " below, going to the furnace, and that passing through ('dust') being sold.

As the fines screened from the shipping-ore have not generally furnished enough clean ore to run the furnace, the deficiency is made up by crushing, in a Buchanan crusher, mixed rock and ore thrown out from the shipping-ore and picked out from the old dumps. This material, after crushing, goes through the washer and separators, with the fine from the mines.

A test of the revolving magnet was made April 15, 1892, all the tails being caught and weighed up, and resulted as follows:

	Pounds.	Iron in Fe_3O_4. Per cent.	Iron in FeO. Per cent.	Total iron. Per cent.
Shot,	1092	49.8	4.9	54.7
Dust,	1014	61.0	2.4	63.4
Tails,	874	11.0	11.1	22.1

There should also be added to the quantity of tails the fine material lost in the wash-water, which amounts to from 5 to 40 per cent. of the whole material treated according to whether clean (tunnel) or dirty (open-cut) ore predominates.

From various tests of this wash-water with hand-magnets, it has been found that the loss of iron in it is negligible, and including the weight of the material in the wash-water would reduce the percentage loss in tails very materially. Inasmuch as half of the loss in tails is in non-magnetic FeO, we may consider the result, on the whole, as a good separation.

During the month of March, 1892, 920 tons of ore from the crusher and 947 tons of 'dirt' from the mine, or a total of 1867 tons, were sent to the washer and separators. From this was recovered 1029 tons of 'clean ore,' averaging 45 per cent. of metallic iron, 47 tons of 'shot' averaging 55 per cent. of metallic iron, and 113 tons of 'dust' averaging 63 per cent. of metallic iron; also 271 tons of tails and 406 tons of fines washed away (by difference) averaging together less than 20 per cent. of metallic iron.

During 1892, therefore, with the original and comparatively crude machinery, about 1100 tons of 'shot' and 'dust' of these high percentages of iron were saved from the waste of the mines, besides a much greater amount of the separated 'clean ore' (larger than 3/16 inch)…"[112]

13 December 1895. American Manufacturer and Iron World.

"Blast Furnaces December 1, 1895. Increased productive capacity is again the main feature of our blast furnace report. The report for the month of November shows an increase of 7377 tons in weekly capacity, with seven more furnaces in operation. During the week 10 coke and bituminous furnaces have blown in. These are the furnaces at… Cranberry, N.C…"[113]

1895. The Balsam Groves of the Grandfather Mountain…

"Between Elk Park and the Cranberry mines the stem-winder stops to let passengers off at the Cranberry Hotel, a perfect gem of a house, which Mr. Wallace Hahn, the proprietor, keeps in the style of a delightful country home.

Along its approaches and around its copious verandas the most beautiful flowers are clumped and clustered upon a verdant lawn, while the commodious apartments within are furnished with every modern convenience, and the dining-hall is rich with the aromatic contents of plenty's horn.

At the mines you can get a square meal for fifty cents, and a day's board and lodging for one dollar and fifty cents, at the Mitchell House.

Persons who stop at Cranberry to see the inexhaustible deposit of magnetic ore and its surrounding objects of interest, will lose the jewel of their sojourn if they fail to visit Colonel C. H. Nimson's Bellevue farm, three miles distant, on top of Fork Mountain, where the splendor of the prospect is all that the name suggests, – 'And harmless shepherds tune their pipes to love, And Amaryllis sounds in ev'ry grove.'"[114]

Summer 1895 – 1896. "Cranberry, North Carolina," by John R. Waite.

"When iron prices finally rose during the summer of 1895, the company decided to resume production. But iron markets remained weak and the furnace was shut down again on June 14, 1896."[115]

1896. The Story of Coal and Iron in Alabama.

Guy Johnson: "In 1896 our company purchased a second furnace at Johnson City, thirteen miles from Embreeville, and at this furnace we made low phosphorus iron out of the well-known cranberry magnetic ore. This was the first time that cranberry ore had ever been used in a modern furnace, and was the first demonstration of the fact that it could be so used."[116]

12 March 1896. The Johnson City Comet.

"Stockholders Meet. The stockholders' meeting of the E.T.&W.N.C. railroad met in the office of the company here Wednesday. Quite a number of the stockholders were present, and the same directory and officers were as follows: Directors, Frank Firmstone, A. Pardee, R.F. Hoke, J.C. Hardin, Geo. Richards, John S. Wise and Dr. H.M. Howe. Officers, Frank Firmstone, president; John S. Wise, secretary and treasurer, and Col. C.H. Nimson general superintendent.

The reports showed the company to be in good shape, and while no immediate improvements were planned, the president in his report said that this year would be as good as 1894.

The furnace of the company is in blast at Cranberry and is making about twenty tons a day…"

14 June 1896. "Cranberry, North Carolina," by John R. Waite.

"iron markets remained weak and the furnace was shut down again on June 14, 1896."[117]

1896. North Carolina and Its Resources.

"The Cranberry Magnetite belt contains by far the most important deposits of ore in this entire region, and has been most extensively developed. The eastern extremity is at Cranberry in the northern part of Mitchell county; thence it extends north 34° west for two and a-half miles to the Tennessee line; crossing the same it passes through the southern portion of Carter county, Tenn., deflecting gradually westward and then southwestward, to the head waters of Tiger creek, recrossing into North Carolina, and continuing in a southwesterly direction to the Toe river, a total distance of some twenty-two miles. The most important development in this belt, if not indeed in the State, is at the Cranberry mine, at the terminus of the East Tennessee and Western North Carolina railroad. The ore deposit is an immense lens of magnetite, associated with hornblende, pyroxene, epidote, quartz, feldspar, calcite, &c. The present workings of the Cranberry mine cover about eight acres on the slope of Cranberry ridge, and consists of two tunnel openings and four main open cuts in successive levels or benches. Altogether the ore body has been opened up and explored in these main workings about eight hundred and seventy-five feet in length, by three hundred feet in breadth, by one hundred and sixty-five feet in average depth, representing approximately 1,600,000 cubic yards. At a low estimate, this volume would contain 4,800,000 tons of ore material. The ore varies in character from very fine grained, dense, massive to soft coarse granular magnetite. Analyses show the ore to vary from forty-five per cent, iron (run of mine) to sixty-eight per cent, from selected masses of ore. It is well within the Bessemer limit as to both sulphur and phosphorus. The ores are smelted in a small coke furnace situated at the mine, and the pig iron is of a special Bessemer grade, averaging less than 1.00 per cent, silicon and 0.025 per cent, phosphorus. It has attained a wide reputation for the manufacture of steel. The annual production has varied from about four hundred tons to a maximum of three thousand two hundred tons. The possibilities of the Cranberry mine as an ore producer have never been fairly demonstrated. It is without exception the largest deposit of Bessemer ore in the South, and its importance and value in this respect are very great."[118]

1896. Directory of Iron and Steel Works of the United States.

"Tennessee. Coke.

Carnegie Iron Company, Johnson City, Washington county. One stack, 75 x 16, nearly completed; work suspended in 1892; three Whitwell stoves, each 65 x 18; will use Pocahontas coke and Cranberry ore; product to be 'special Bessemer' pig iron; annual capacity, 36,000 gross tons. J.T. Wilder, President; J.W. Cure, Secretary and Treasurer; H.W. Hargreaves, Superintendent. For sale…

North Carolina. Coke…

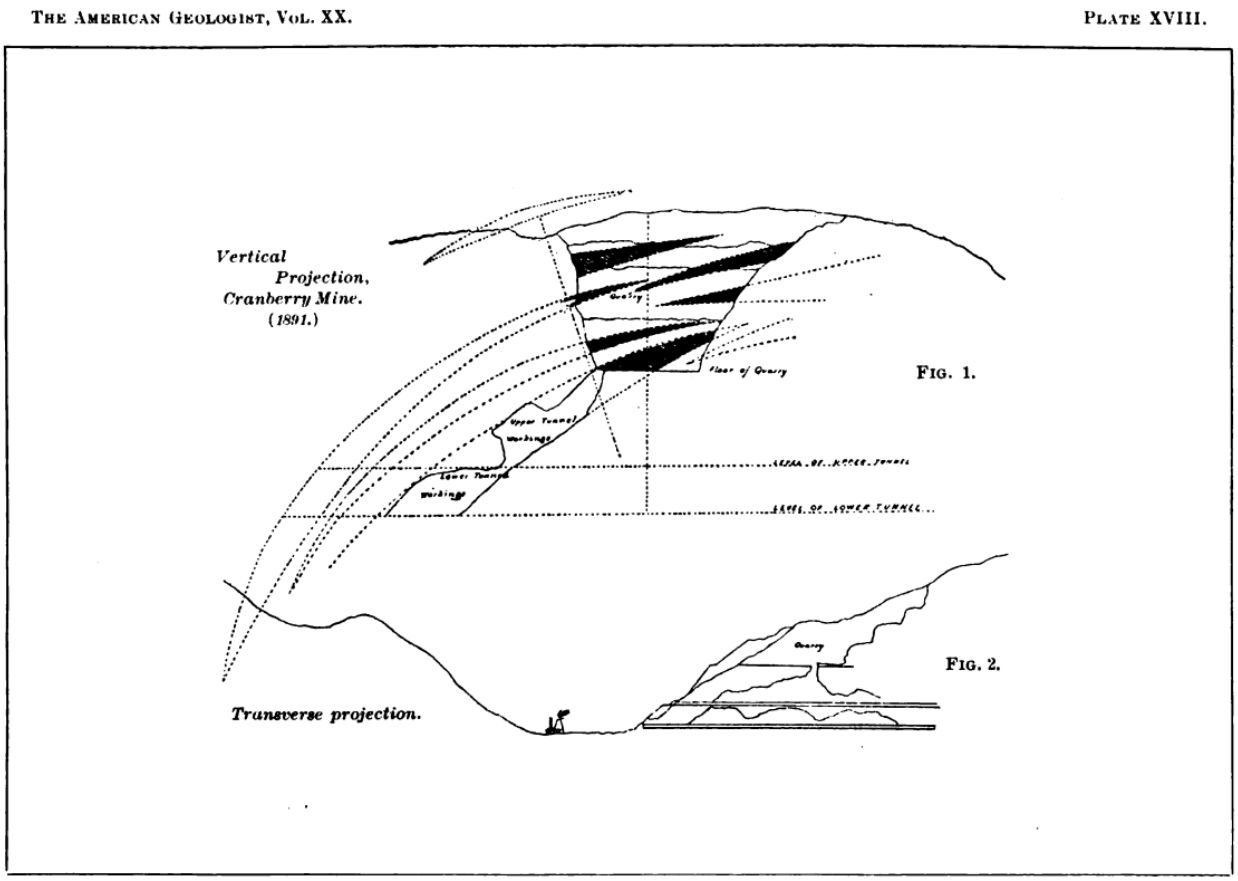
Cranberry Furnace, Cranberry Iron and Coal Company, Cranberry, Mitchell county. Philadelphia office, 240 South Third st. One stack, 50 x 11½ , built in 1883-4, and blown in April 16, 1884; hot and cold blast; fuel, coke, but formerly used charcoal; ore, magnetic, mined on the company's property; product, pig iron of Bessemer quality; annual capacity, 5,200 gross tons. Brand, 'Cranberry.' Frank Firmstone, President; J.S. Wise, Secretary and Treasurer; C.H. Nimson, General Manager. Selling agents, Matthew Addy & Co., Cincinnati.

Number of furnaces in North Carolina: 2 coke stacks."[119]

9 September 1897. Watauga Democrat.

"No evidence of Cranberry works resuming operations. Why is this?"

November 1897. "On the Magnetite Belt at Cranberry, North Carolina, and Notes on the Genesis of this Iron Ore in General in Crystalline Schists," by James P. Kimball.



"Sectional Sketches, Cranberry Mine."

"The narrow bottom of Cranberry creek some 50 feet below the mines is occupied by the iron works and railroad (E. Tenn. & W.N.C.) both built by the Cranberry Iron and Coal Co., of Philadelphia, and operated as well as the mines by that company. The works consist of a single

small blast furnace, built in the year 1884, making about twenty tons of iron per day from a 43 per cent, ore, ordinarily with Flat-top or Pocahontas coke. The furnace is chiefly remarkable for its production of iron with a tenor of phosphorus as low as 0.020 per cent, from an ore of comparatively low grade, an achivement in regular practice probably unequalled in the country. This result is due not only to the remarkably minute proportion of this deleterious substance in the furnace stock, but to the care and skill exercised by the president, Mr. Frank Firmstone of Easton, Pa., who has devoted much personal attention at the furnace to the production of iron of high grade…

The Cranberry mine is wrought partly in open quarry and partly by levels, the separate workings being connected on the dip. Parts of six distinct ore lenses are exhibited on the face of the quarry one above another and in echelon. These, defined in short as differentiations or concentrations of magnetite in the augitic belt, pass insensibly into non-feriferous material. The lowermost of these, the largest of the series, is likewise wrought in the underground workings.

The lower level 330 feet in length enters the ridge directly beneath the railroad bank 30 ft. above drainage, or 95 ft. below the level of the quarry floor at nearly right angles with the strike of the formation; It therefore cross-cuts members of the formation next below the horizon of the ore-belt and just penetrates the hanging wall of the main ore-body. These members are essentially foliated and gnarled hornblendic gneiss only slightly epidotic at this level and sparsely strewn with zircons. The thickness of the ore-body on the tunnel line is 87 ft. Measurements, however, vary with the section, and, apart from a few as already given, exact dimensions remain undetermined. Exploration by diamond drill 142 ft. beyond the innermost heading reveals alternations of ore and pyroxene and amphibole more or less epidotic. This goes to show the presence if not the maintenance of ore-lenses at this level the same as in the upper workings, but none of remarkable thickness. Their indication is rather of the attenuation of lenses or concentrations of which larger sections are exhibited in the face of the quarry. The lack of sharp demarcation in the ore lenses renders boring unsatisfactory as a mode of exploration. The following inverse section was recorded:

	Excavation	Gneiss more or less ferriferous	101 ft.
		Main ore body at adit level	70 ft.
6 ft.	[Excavation] Ore		6 ft.
29 ft. 8 in.	[Excavation] Epidotic gneiss		23 ft. 8 in.
34 ft. 8 in.	[Excavation] Interval		5 ft.
38 ft. 2 in.	[Excavation] Ore		3 ft. 6 in.
41 ft. 11 in.	[Excavation] Ore and amphibole (pyroxene?)		3 ft. 9 in.
42 ft. 3 in.	[Excavation] Good ore		0 ft. 4 in.
46 ft. 10 in.	[Excavation] Interval		4 ft. 7 in.
88 ft. 6 in.	[Excavation] Good ore		41 ft. 8 in.
142 ft. 3 in.	[Excavation] Interval		53 ft. 9 in.

The lower workings have been carried upward so as to open into earlier workings connecting with the upper tunnel, so-called, 35 ft. higher, or 65 ft. above water level. This was driven through about 80 ft. of talus round a turn of the hillside so as to reach the ore belt on the strike, and therefore nearly at right angles to the lower tunnel now in use. It thus gives access to a portion of the main ore body on the dip intermediate between the quarry and the lower workings, and especially to solid ground not yet penetrated from the lower level but still below the level of

the quarry. Ore broken on this level can be delivered through the lower level, the two workings having been 'holed' through on the font wall. Underground workings thus connected rise to near the floor of the quarry, at the nearest edge of which at one point they break through to daylight. The thickness of the main ore body at the level of the upper tunnel is 65 ft. The difference in section at the two tunnels is due to the lenticular configuration of the ore lens. All of the workings advance in the direction of the strike. Neither workings on the strike exceeded 400 ft. in length in the year 1891, and 40 ft. in hight, while both are driven into solid ground beyond the vertical of the quarry face.

The quarry face is advanced from the floor and from two benches above, the former being 45 ft. above the upper level. Three working breasts are thus maintained each 50 ft. in hight. Abandoned shallow excavations still higher on the hillside expose an upper lens. These were wrought for the sake of iron sands from disintegration of this small superficial division of the ore belt. The face of the hillside now occupied by the present quarry was originally wrought in the same way for the supply of the old bloomary.

The thickness of the ore belt at the surface as shown by graphic construction is about 250 ft. including the upper lens, or 205 ft. to the superficial edge of the quarry, these measurements being at right angles to the dip. The horizon of the foot wall is clearly defined in the lower tunnel, at which level the ore developments, judging from the boring, seem limited to a thickness of 152 ft. The upper and middle divisions of the ore belt are disclosed in the quarry face, though nothing like a hanging wall has been reached in any of the workings. From the present compass of the quarry it has been eroded.

Of any given thickness of the ore belt only a varying portion is made up of workable ore. A large proportion of the refuse is adapted to magnetic separation ore concentration. From the above description it will be understood that besides the main ore body which crosses the whole quarry face, passing on the rise into the right wall, attenuating parts of five lenses similarly disposed are wrought in the quarry all of which in the summer of 1891 could be more or less distinctly traced by coloration. It also appears that the net thickness of the differentiated ore lenses varies at intervals with the section…"[120]

26 August 1898. The Semi-Weekly Messenger.

"A large force of men are now preparing the well-known Cranberry iron mines in Mitchell county, for the resumption of work September 1st, after five years of idleness. On that date 200 men will be put to work, getting out the ore, which will be shipped to the Embreeville Iron Company, at Johnson City, Tenn., and there made into iron and steel."

8 September 1898. The Johnson City Comet.

"Shipments of Ore Commenced. The Cranberry Iron Company has commenced shipping ore to the Embreeville furnace people. Several car loads will be shipped to Embreeville to test in the furnace in that place before the furnace here is put in blast. Ore is being transferred daily for shipment to Embreeville. If the test is satisfactory, and there is no doubt that it will be, regular daily shipments will be made to the furnace at this place."

13 September 1898. The Semi-Weekly Messenger.

"The news of the resumption of work at the Cranberry iron mines, after years of idleness, is gratifying. The ore is among the purest and best in the United States. It has been mined and smelted in a rude way since the earliest white settlement of that part of the state. General R.F. Hoke, the principal owner of the mine, tells me that the iron, smelted in a catalan furnace and rudely forged into bars, was for many years 'shipped' on the backs of the oxen. Now the ore is being shipped to Tennessee and smelted."

November 1898. "Cranberry, North Carolina," by John R. Waite.

"The Carnegie Furnace, operated by Virginia Iron, Coal & Coke, and the Embryville furnace, operated by Embryville Iron Company, south of Johnson City placed orders for iron ore in 1898. The mines were reopened in November 1898, but the furnace remained out of service. After sitting idle for two years, the mine facilities needed repairs and additional equipment to meet the new demand. Superintendent Nimson was authorized to buy a 40-horsepower boiler, a couple of Rand drills, and assorted other items to increase the output of the mines. Calls also went out for '500 good, able-bodied workmen,' who could earn $1 per day working in the mines."[121]

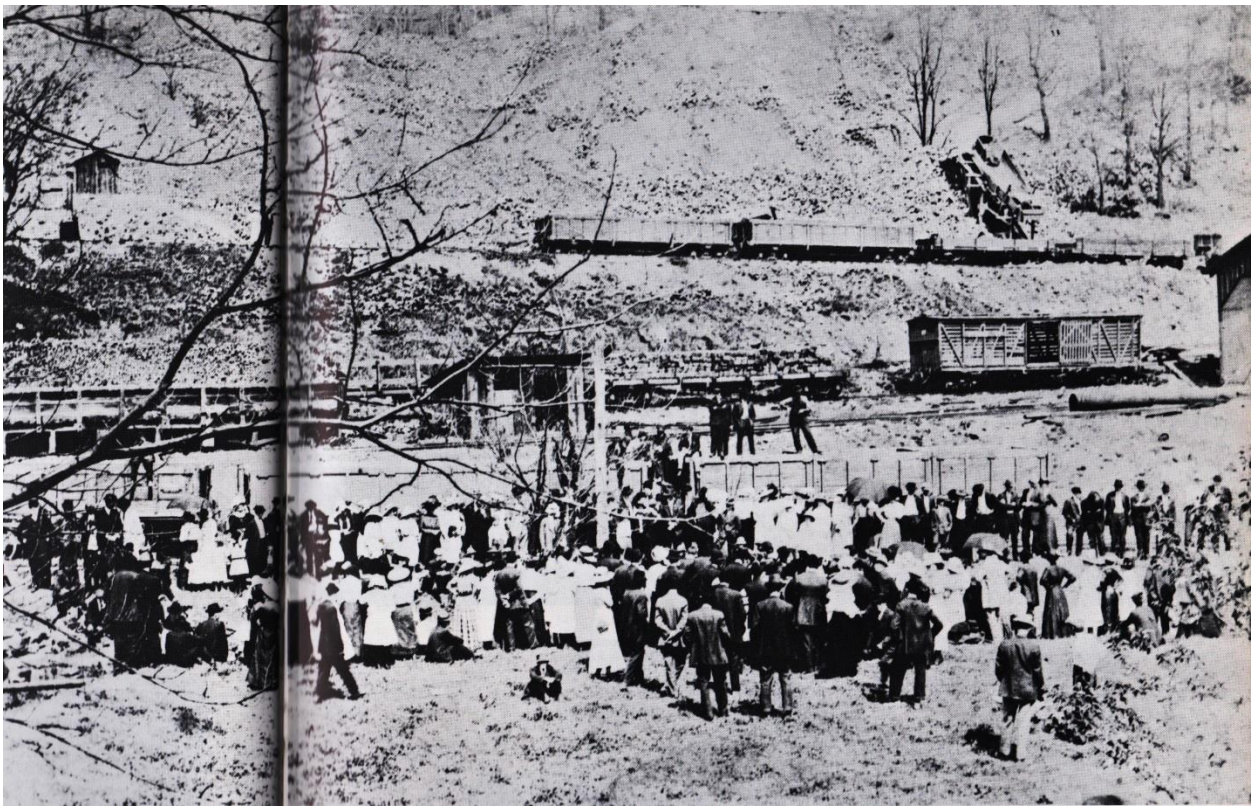


Figure 44. "The ET&WNC and LR lines ran through the heart of the 'Bible Belt' and so it was not unusual for them to issue passes for free passes to members of the clergy. ET&WNC Superintendent Hardin would not allow trains to run on Sundays for many years. A baptism takes place (above) in Cranberry Creek, below the Linville River's engine-house…" Based on the presence of the 32-foot stock car, this photo was taken after 1898. This photo is included because it provides some detail of an ore chute as well as some of the other buildings in the vicinity of the Cranberry Mine.[122]

1898. Directory to the Iron and Steel Works of the United States.
"Tennessee. Coke.

Carnegie Furnace, Carnegie Furnace Company, Johnson City, Washington county. One stack, 75 x 16, nearly completed by the Carnegie Iron Company; work suspended in 1892; the present owners expect to complete the stack in 1898; three Whitwell stoves, each 65 x 18; will use Pocahontas or Stonega coke and Cranberry ore; product to be 'special Bessemer' pig iron; annual capacity, 36,000 gross tons. H. Frederick Stone, President; George W. Dally, Secretary and Treasurer. For sale. Address Wilberforce Sully, 29 Broadway, New York City.—Not completed; for sale…

North Carolina. Coke.

Carolina Furnace, The Greensboro Furnace Company, Greensboro, Guilford county… Never blown in.

Cranberry Furnace, Cranberry Iron and Coal Company, Cranberry, Mitchell county. Philadelphia office, 240 South Third st. One stack, 50 x 11½, built in 1883 – 4 and blown in April 16, 1884; hot and cold blast; fuel, coke, but formerly used charcoal; ore, magnetic mined on the company's property; product, pig iron of Bessemer quality; annual capacity, 5,200 gross tons. Brand, 'Cranberry.' R.F. Hoke, President; J.S. Wise, Secretary and Treasurer; C.H. Nimson, General Manager. Selling agents, Matthew Addy & Co., Cincinnati.—Active in 1896.

Number of furnaces in North Carolina: 2 coke stacks. No charcoal stacks."[123]

9 March 1899. The Johnson City Comet.

"The Furnace. There have been all sorts of wild rumors floating around about the Carnegie Furnace, all tending to create the impression that the furnace was about to close down. Nothing could be further from the truth. On account of a slight misunderstanding last week between the furnace company and the Cranberry Iron and Coal company, the shipment of iron was stopped for two days, but the difficulties have been adjusted and the ore is being shipped regularly."

5 December 1899. The Semi-Weekly Messenger.

"Statistics Given Out in Advance by the Secretary Cranberry Iron Works. To Reopen the Railway Tax Assessment Case. (Special to The Messenger.) Raleigh, N.C., December 2. – General Hoke says the smelter is nearly completed at Cranberry iron mill. Its capacity will be 150 tons daily."

16 January 1900. Engineering and Mining Journal.

"The Cranberry Iron and Coal Company's furnace at Cranberry, N.C., which has been shut down since 1896, was started up on January 16th."[124]

18 January 1898. "Cranberry, North Carolina," by John R. Waite.

"The Cranberry furnace was restarted on January 18 [16? See above], 1900, but not by CI&C. Frank Firmstone, who served as president of CI&C prior to 1897, and his brother, Harry,

had extensive experience in the iron industry. In late 1899, they made an offer to lease the furnace from CI&C.

The Firmstones agreed to put the furnace in good working order, to buy their ore from the Cranberry mine, and to pay prevailing freight rates for the transportation of the limestone and coke over the ET&WNC. One year's rent would be $1000, and CI&C would receive 25 percent of the net profits. The railroad was required to relay the rails for the coke, limestone, and cinder tracks that had been taken out when the furnace was shut down in 1896."[125]

23 January 1900. The Semi-Weekly Messenger.

"Iron Works Start up. Charlotte, N.C., January 18. – The Cranberry Iron and Coal Company's furnace, at Cranberry, N.C., started up yesterday, giving employment to 100 laborers. Work at this plant had been shut down since 1896."

17 February 1900. Iron and Steel.

"The Cranberry Iron & Coal Company's furnace at Cranberry, N.C., has been put in blast, giving employment to about 100 labourers. This furnace has not been in operation since 1896."[126]

1 March 1900. Johnson City Comet, similar in the Watauga Democrat of the same date.[127]

"Notice, Notice. From and after March 1st, 1900, the Cranberry Iron & Coal Company will have work for 500 good, able-bodied workmen at the Cranberry Mines, and will pay such men $1.00 a day (in the Mines.

Apply to Capt. J.F. Huddle, Superintendent of Mines, at Cranberry, N.C.

C.H. Nimson, General Manager.
Cranberry, Feb. 23rd, 1900…

To be Reopened. The Cranberry magnetic ore iron mines, which has been closed for sometime has reopened. The mines will afford employment for 500 men when in full operation. Some difficulty has been experienced in securing the requisite number of men…"

17 March 1900. The Black Diamond.

"Southern Coal and Coke Notes… The Cranberry Iron & Coal Co., Bristol, Tenn., purposes doing an extensive shipping trade and has advertised for 500 additional miners."[128]

22 April 1900. Richmond Times.

"Colonel C.H. Minson [Nimson], superintendent of the Cranberry Magnetic Iron Mines, in Western North Carolina, was in Bristol this week. He has a force of 200 miners employed, and states that the company's orders for ore are such that he could work three times the number

of men at present employed if he could only secure as many. This company does mainly a shipping business, having only one furnace, with a daily capacity of thirty tons."

24 May 1900. Johnson City Comet.

"In Best of Condition. Col. Frank Firmstone, of Cranberry N.C., is stopping at the Imperial.

Col. Firmstone is a large stockholder in the celebrated Cranberry magnetic ore mines and the East Tennessee and Western North Carolina railway. At present he is acting as superintendent of the mines which he says, are still producing a high grade of magnetic ores. There are about 300 miners employed there now and about 250 tons are mined a day. The company also operates a small blast furnace which makes one hundred tons a week of a high grade of magnetic pig. Most of the ore shipped is used in the furnaces at Johnson City and Embreeville.

Col. Firmstone reports the mine and lumber interests in good condition in his section and that business is still good. He says that Col. C.H. Nimson who resigned some time ago as general manager of the E.T. & W.N.C. railway, was succeeded the first of May by James E. Lawton, of Middlesboro.

Col. Nimson, who has for a number of years been interested in fine sheep-raising at Bellvue, his mountain farm, will devote all his time to that business which has proven so congenial and profitable to him. Knoxville Journal."

26 May 1900. Engineering and Mining Journal.

"Mitchell County. Cranberry Magnetic Iron Mines. – The company has 200 miners busy, but the demand for ore exceeds the capacity of the present force. C.H. Munson is superintendent."[129]

1 June 1900. "Cranberry, North Carolina," by John R. Waite.

"The Carnegie Furnace broke down on June 1, 1900. All shipments of ore to the Johnson City plant stopped and Virginia Iron, Coal & Coke went into receivership. In late 1900, the mines were again shut down."[130]

7 June 1900. Richmond Dispatch.

"Mines Shut Down. – Bristol, Tenn., June 6. – (Special.) – News was received here to-day that the iron mines and furnace at Cranberry, N.C., the property of a Pennsylvania company, have been shut down on account of the slump in iron. This action throws about 200 men out of employment."

14 June 1900. Johnson City Comet.

"The ore mines at Cranberry, N.C., have not been shut down, as reported. On account of the closing of the furnace at Johnson City that was running on Cranberry ore, several hands have

been thrown out of employment. Only enough ore is now being mined to supply the furnace at Cranberry."

21 June 1900. The Iron Trade Review.

"The magnetic iron mines at Cranberry, N.C., have been shut down for lack of demand."[131]

19 July 1900. American Manufacturer and Iron World.

"On account of the slump in iron, the iron mines and furnaces at Cranberry, N.C., have been banked and 200 men are thrown out of employment."[132]

15 September 1900. Fourteenth Annual Report of the Bureau of Labor and Printing of the State of North Carolina for the Year 1900.

"Elk Park, September 15, 1900.
B.R. Lacy, Esq., Labor Commissioner, Raleigh, N.C.
Dear Sir: - The foregoing answers relate to this immediate vicinity, or rather the northeastern part of Mitchell County, including Cranberry, Linville, Toe River and Roaring Creek Townships, and to farm labor alone. The lumber industries furnish work for many men, and give a good home market for the products of the farm. The iron interests does not count for much to this section, because of its unsteadiness and because when at work most of the labor employed is drawn from a distance. The best need for a farm wage earner is better agricultural education, trained to more systematic work so as to work with more intelligence and less brute force and awkwardness. If children at school were taught the elements of agriculture and to become more interested in what is to be their life's occupation, it would be worth much more to them and to the country at large, than the present system, which seems to drift towards dependency, or occupations that are already crowded by the too many incompetent workers, and the tenure of which is new, and will continue to become, more and more uncertain as nepotism prospers.

Yours truly, C. H. Nimson."[133]

6 October 1900. "Cranberry, North Carolina," by John R. Waite.

"The Firmstones operated the furnace [at Cranberry] until October 6, 1900, making over 3,000 tons of 'Cranberry' pig iron. It was the last time the Cranberry furnace was operated."[134]

18 October 1900. The Iron Trade Review.

"The Cranberry Iron & Coal Co. will soon blow in its furnace at Cranberry, N.C."[135]

1900. Thirteenth Annual Report of the Bureau of Labor and Printing of the State of North Carolina for the Year 1899.

"The Cranberry iron mine, the most noted in the State, has been operated for some time, and now reports a daily shipment of about one hundred and fifty tons of iron ore. It is said that during the year 1900 the shipments of ore will be increased, and that the blast furnace at Cranberry, which has been idle for some time, will be kept in blast during this year. The company is employing, at the present time, about one hundred and forty men."[136]

1900. "General Features of the Magnetite Ores of Western North Carolina and Eastern Tennessee," by W.S. Bayley.

"In 1900 this furnace [at Cranberry, N.C.] was abandoned, a larger one having been built by the Cranberry Furnace Co. at Johnson City…"[137]

1900. Mining Industry in North Carolina during 1900.

"At Cranberry, Mitchell county, the Cranberry Iron and Coal Company have worked their mine of magnetic iron ore continuously throughout the year. This is the best known iron mine in the State, and has been operated almost continuously since that company has owned it. Besides the actual mining the company started some development work which more than met their expectations. In order to determine the direction of the deposit or the dip, a slope some twelve feet wide and eight feet high was sunk in the old underground workings, which is now one hundred and fourteen feet long and with an inclination of about fifteen degrees. For nearly one hundred feet back from the present head of the slope no dead rock was taken out, all the material taken out being good ore. It is intended to drive this slope one hundred feet farther at about the same inclination if the ore continues, and then to stope out the ore upward. The outlook at this mine for the coming year is most favorable."[138]

May 1901. "Cranberry, North Carolina," by John R. Waite.

"The May Tide of 1901 severely damaged the ET&WNC between Johnson City and Cranberry."[139]

1 August 1901. "Cranberry, North Carolina," by John R. Waite.

"On August 1, 1901, George Hardin replaced James Lawson as general manager of the mines and railroad. He soon had the railroad repaired and in operation."[140]

27 August 1901. Richmond Dispatch.

"It is stated that the Virginia Iron, Coal and Coke Company has leased its modern iron furnace at Johnson City, Tenn., to the Cranberry Iron Company. The latter company will manufacture bar pig from the famous steel-producing ore that abounds in the mountains at Cranberry, N.C."

29 August 1901. The Iron Trade Review.

"The Cranberry Iron & Coal Co. of Cranberry. N.C., have purchased the Carnegie furnace of the Virginia Iron, Coal & Coke Co., located at Johnson City, Term. The furnace will

shortly be blown in after an idleness of nearly two years. It has a daily capacity of about 150 tons."[141]

1 September 1901. The Tradesman.

"Johnson City, Tenn.—The Cranberry Iron and Coal Co. has purchased the Carnegie blast furnace at this place from the Virginia Iron, Coal and Coke Co., and will arrange at once to put it into blast. The deal was practically arranged about two months ago through the receivers of the Virginia Iron, Coal and Coke Co. in Virginia, but no announcement was made at that time. The work of repairing the furnace will begin at once and probably within thirty days it will be in operation. It has been more than a year now since the furnace was last operated by the Virginia Iron, Coal and Coke Co. It was then in good repair and will not require much work to get it in readiness for blast. It has a daily capacity of 150 tons."[142]

2 September 1901. "Construction of Johnson City's Carnegie Furnace stopped with the depression of 1893, but work resumed under new ownership in the mid-1890s. In January 1899, the furnace was blown in when, as one newspaper reporter quipped, the mayor of Johnson City 'lighted the match that kindled the flames to melt the iron in the furnace which General Wilder built.' On September 2, 1901, the Cranberry Furnace Company, a subsidiary of the Cranberry Iron and Coal Corporation and owners of the Cranberry ores and the ET&WNC, purchased the Carnegie furnace."[143]

2 September 1901. "During the receivership, a lease and option to purchase was given to the Cranberry Furnace Company of the Carnegie furnace, near Johnson City, Tenn., for $70,000, which option the lessees – availed themselves of… Rental Carnegie Furnace [$]4,333.32"[144]

2 September 1901. "Virginia Iron, Coal and Coke Co.—Incorporated Jan. 19, 1899, in Virginia… The company became insolvent and was placed in the hands of receivers. During the receivership, which continued from Feb. 6. 1901, to Jan. 1, 1903 (at which date the receivers were discharged and the company took possession of its property)… During the receivership, a lease and option to purchase was given to the Cranberry Furnace Co. of the Carnegie furnace, near Johnson City, Tenn., for $70,000, which option the lessees availed themselves of."[145]

15 September 1901. The Tradesman.

"James A. Martin, Johnson City, Tenn. —Trade conditions look better for the lumber business since the hot weather is over. There is a splendid demand for white pine and all hardwoods except calls and commons. These latter grades will bring better prices for winter delivery. Prices for culls are bound to go up, as they cannot be manufactured long at present prices. The Cranberry Iron and Coal Co. have leased the 150-ton furnace at this place for three years, with the Privilege of buying same. As they have an inexhaustible supply of magnetic iron ore they can run the furnace with success. This, together with the Soldiers' Home and bright prospects for additional railroad lines, makes conditions very encouraging for Johnson City."[146]

26 September 1901. The Iron Trade Review.

"The Cranberry (N.C.) Iron & Coal Co. has purchased the Carnegie iron furnaces at Big Stone Gap, Va."[147]

27 October 1901. Richmond Dispatch.

"General R.F. Hoke has returned here from the Cranberry iron mine, in Mitchell county, in which he is largely interested. No ore is now being mined, but great preparations are being made for resuming that work. He is very anxious to see the railway completed across the Blue Ridge, giving an outlet this way, as now the Cranberry section is literally cut off from other points of the State, its relations being almost entirely with Tennessee and a little with Virginia."

1 November 1901. The Tradesman.

"A Johnson City, Tenn., correspondent says: Preliminary arrangements are being made by the Cranberry Iron and Coal Co. to start the Carnegie furnace at this place. Some time ago negotiations were begun by this company for a lease of the furnace property, and it is now reported that these have been practically consummated. It is expected that the furnace will be prepared for blast soon."[148]

1 December 1901. The Tradesman.

"The Cranberry Coal and Iron Co., has leased the Carnegie blast furnace at Johnson City, Tenn., and the plant is being repaired preparatory to going in blast."[149]

5 December 1901. The Johnson City Comet.

"Master Mechanic Simcox. Sam Simcox came up from Knoxville last week to accept a position as Master Mechanic with the Cranberry Iron & Coal Company. He will have general supervision of the work at the mines at Cranberry and the furnace in Johnson City. He is now at Cranberry and will make some extensive improvements at the mines. One of the most important items will be the installing of a magnetic ore separator and pulverizer so that the ore may be shipped to the furnace here 90 per cent. pure iron…"

12 December 1901. The Iron Trade Review.

"The Cranberry Iron Co., has taken charge of the Carnegie Furnace at Johnson City, Tenn., and will make repairs."[150]

15 December 1901. Richmond Dispatch.

"The Cranberry Iron and Coal Company, which recently leased the Carnegie iron furnace at Johnson City, and is having it repaired at a cost of about $60,000, has resumed ore mining at the Cranberry magnetic iron mines."

28 December 1901. Engineering and Mining Journal.

"Flood Damages… The mines at both Cranberry and Crystal Ridge were flooded, and it will take some time before there is a full resumption of work. In the Cranberry Mine there were 21 mules drowned."[151]

1901. Mining Industry in North Carolina during 1901.

"The most noted iron mine in the State is the magnetite iron mine at Cranberry, Mitchell county, which is at the terminus of the East Tennessee and Western North Carolina Railroad. The ore body consists of an immense lens of magnetite that has associated with it hornblende, pyroxene, epidote, quartz, feldspar, calcite, garnet, zircon, allanite, serpentine, etc., in varying proportions. The ore is distributed in irregular masses through the gangue and at times intimately associated with the same in thin bands. The thickness and extent of these bands are variable, from a few inches to more than fifty feet.

Nearly all the iron produced in 1901 was from this mine, and amounted to 2,578 tons valued at $4,997, as compared with a production of 21,000 tons in 1900 valued at $42,000. The Cranberry mine was not operated for the greater part of the year, the time being spent in development work and improvements to the plant. It is expected that in 1902 there will be a constant output per month that will make the total production for the year greater than that of 1900. The other mine producing iron in 1901 was the Potato creek mine, located in the Piney Creek district, Alleghany county, and contains magnetic ore."[152]

1901. Directory of Iron and Steel Works of the United States and Canada.

"Tennessee. Coke Furnaces – 15…

Johnson City Furnace, The Cranberry Furnace Company, lessee, Johnson City, Washington county. Philadelphia office, Drexel Building. One stack, 74¼ x 18, partly erected by the Carnegie Iron Company; work suspended in 1892; stack completed in 1898 by the Carnegie Furnace Company and blown in January 2, 1899; three Whitwell stoves, each 65 x 18; fuel, coke; ore, Cranberry; product, low-phosphorus pig iron; annual capacity, 30,000 gross tons. Brand, 'Cranberry.' Frank Firmstone, President, Johnson City; Calvin Pardee, Vice-President, and F.P. Howe, Secretary and Treasurer, 225 Drexel Building, Philadelphia. (Formerly called the Carnegie Furnace. Owned by the Virginia Iron, Coal, and Coke Company.) – Last active in 1900, but will be blown in in the spring of 1902..."

"Virginia Iron, Coal, and Coke Company… The company operates the following works: Blast Furnaces – 1 Charcoal and 12 Coke Stacks…

Carnegie Furnace, Johnson City, Washington county, Tennessee. One stack, 74¼ x 17½, partly erected by the Carnegie Iron Company; work suspended in 1892; stack completed in 1898 by the Carnegie Furnace Company and blown in January 2, 1899; three Whitwell stoves, each 65 x 18; fuel, Looney Creek or Stonega coke; ore, Cranberry; product, low-phosphorus and Bessemer pig iron; annual capacity, 43,000 gross tons. Brand, 'Carnegie.' J.W. Cure, Superintendent. (Formerly operated by the Carnegie Furnace Company.) – Active in 1900."

"North Carolina. Coke Stacks – 2.

Cherokee Furnace, Empire Steel and Iron Company, Catasauqua, Lehigh county, Pennsylvania. Furnace at Greensboro, Guilford county, North Carolina…

Cranberry Furnace, Cranberry Iron and Coal Company, Cranberry, Mitchell county. Philadelphia office, 240 South Third st. One stack, 50 x 11½, built in 1883-4 and blown in April 16, 1884; hot and cold blast; fuel, coke, but formerly used charcoal; ore, magnetic mined on the company's property; product, pig iron of Bessemer quality; annual capacity, 5,200 gross tons. Brand, 'Cranberry.' R.F. Hoke, President; J.S. Wise, Secretary and Treasurer.—Active in 1900.

Number of furnaces in North Carolina: 2 coke stacks. No charcoal stacks. There are no rolling mills or steel works in North Carolina."[153]

15 February 1902. The Tradesman.

"The Cranberry Iron and Coal Co., owning extensive magnetic iron ores in western North Carolina, has purchased the furnace of the Virginia Iron, Coal and Coke Co., at Johnson City, Tenn., and will make improvements at a cost of $75,000."[154]

Spring 1902. "Cranberry, North Carolina," by John R. Waite.

"A group of CI&C stockholders acquired the Carnegie Furnace from the bankrupt Virginia Iron, Coal & Coke Company. The newly formed Cranberry Furnace Company put the old Carnegie Furnace, newly renamed Cranberry Furnace, into blast in the spring of 1902.

The Cranberry mines returned to full production to supply ore. The company houses were all repaired and porches were added to most. A water system was installed with water coming by pipe from a mountain spring far up Tucker Hollow. The old furnace in the valley was torn down."[155]

19 April 1902. Richmond Dispatch.

"The Carnegie Iron Furnace, near Johnson City, has just been repaired by its lessee, the Cranberry Iron and Coal Company, and it to go into blast at an early date. This furnace, which has a capacity of 150 tons per day, will be used for smelting the Cranberry magnetic ores, which are a very fine steel-producing variety, yielding especially a quality of steel suitable for fine cutlery."

2 May 1902. Richmond Dispatch.

"The Carnegie Iron Furnace, which was recently leased by the Cranberry Iron and Coal Company, was put in operation today, after having been remodeled at a cost of about $90,000.

This furnace, located near Johnson City, East Tennessee, will be used exclusively for smelting the Cranberry magnetic ores from the mines at Cranberry, N.C.

These ores are strictly a steel-producing variety. The Carnegie furnace has a daily capacity of 150 tons."

7 October 1902. Richmond Dispatch.

"Raleigh, N.C., October 6… General Robert F. Hoke left to-day for his iron mine, at Cranberry, in Mitchell county. He says the output is now 250 tons a day, this all going to the

furnaces at Johnson City, Tenn. He is much pleased at the rapid building of another railway into Mitchell."

1902. "Iron-Ore Deposits of the Cranberry District, North Carolina-Tennessee," by Arthur Keith.

"At the Cranberry mines open cuts have been made at intervals over an area 900 by 300 feet and through a vertical distance of 250 feet. From these tunnels are run in for considerable distances… The ore is very free from the objectionable elements, phosphorus and sulphur, though it is not high in iron. It yields an average of 42 to 46 per cent of iron with ordinary concentration. Considerable trouble is experienced in freeing the ore from the gangue before smelting, on account of the tough and refractory nature given to the mass by the epidote…"[156]

25 July 1903. The Bulletin of the American Iron and Steel Association.

"While the Cranberry Iron and Coal Company has for the present abandoned its furnace at Cranberry, N.C, the stack will not be dismantled. The iron ore mines of the company were leased some time ago to the Cranberry Furnace Company, which is now producing low-phosphorus pig iron at Johnson City, Tenn., from ore obtained from the Cranberry deposit."[157]

8 January 1903. Johnson City Comet.

Will make Coke. Under the heading, 'Happenings in old Virginia,' the Bristol Courier gets this item from some source:

'R.L. Brown, of Big Stone Gap, was yesterday awarded a contract by C. Pardee to erect 200 cottages on Black Creek in Wise county. Mr. Pardee recently let contracts for the erection of 500 coke ovens on Black Creek, and the cottages will be used by his employees.'

The C. Pardee mentioned is a Philadelphia capitalist and largely interested in the Cranberry mines and furnace. From the above item it is evident that an effort is to be made to supply the furnace here with coke. It has been rumored here for some time that the company would build two more furnaces here at once to make Cranberry pig, and might put in a steel plant a little later on. Nothing definite can be given out at this time, but it is very evident that the company is laying the foundation for something on a large scale."

8 August 1903. The Iron and Machinery World.

"Blast Furnace Operations during the Half Year… While the Cranberry iron & Coal Company have for the present abandoned their furnace at Cranberry, N.C., the stack will not be dismantled. The iron ore mines of the company were leased some time ago to the Cranberry Furnace Company, who are now producing low-phosphorus pig iron at Johnson City, Tenn., from ore obtained from the Cranberry deposit."[158]

8 July 1904. The Semi-Weekly Messenger (Wilmington, North Carolina).

"General Robert F. Hoke was here today, and will return to his headquarters among the Cranberry iron mines, in Mitchell county. He says three hundred persons are now employed in

getting out the ore from this mine. It is sent by rail to Johnson City, Tenn. That part of North Carolina is shut out from the remainder of this state by the great mountain wall…"

4 November 1904. The Semi-Weekly Messenger (Wilmington, North Carolina).

"General Robert F. Hoke, who is so largely interested in the iron mines at Cranberry is here for a day or two and says work is very active there, over 300 men being employed."

8 December 1904. American Manufacturer and Iron World.

"The Carnegie furnace, which is the property of the Virginia Iron, Coal & Coke Company, but which was leased to the Cranberry Iron Company has been in blast all along and is turning out a superior grade of steel producing and high grade of foundry iron. In this furnace the Cranberry magnetic ore and the hematite ores are being mixed."[159]

1904. Mining Industry in North Carolina during 1904.

"During 1904 the only [iron] mines that were operated were the celebrated Cranberry mines, at Cranberry, Mitchell County, which contains magnetic iron ore and furnishes a pig-iron of superior quality. This mine is the most famous and noted one in the State and has been the only constant producer of iron ore. The other property that was worked was a deposit of brown hematite iron ore near Andrews, Cherokee County… The total production of iron ore in North Carolina during 1904 amounted to 64,347 long tons, valued at $79,846, and was obtained from Mitchell and Cherokee Counties. As compared with the production of 82,851 tons, valued at $78,540, the 1904 production is a decrease of 18,534 tons in quantity, but an increase of $1,306 in value."[160]

28 April 1905. The Railway Age.

"East Tennessee & Western North Carolina. – A meeting of the stockholders will be held on June 14 to vote on the question of purchasing four miles of railroad in Mitchell County, N.C., from the Cranberry Iron & Coal Company and to authorize an issue of $500,000 in bonds."[161]

16 March 1905. The Iron Age.

"The Cranberry Furnace Company, Johnson City, Tenn., which has for the past three years operated Carnegie Furnace at that place, producing low phosphorus pig iron from ore from the Cranberry mine, has purchased the stack from the Virginia Iron, Coal & Coke Company. The gentlemen interested in the furnace company are all interested in the Cranberry Iron & Coal Company, which owns the Cranberry mine, and the company will continue under an arrangement that it has with the Cranberry Iron & Coal Company for the operation of the Cranberry mine."[162]

16 March 1905. The Iron Trade Review.

"The Cranberry Furnace Co., Johnson City, Tenn., has purchased from the Virginia Iron, Coal & Coke Co. the furnace erected by the Carnegie Iron Co. in 1898, and the rich iron ore mines at Cranberry. The Cranberry Furnace Co. is officered as follows: President, Calvin Pardee;

vice president, H.M. Howe; secretary and treasurer, F.P. Howe; manager, L.P. Ross. The company has been the lessee of the furnace, whose annual capacity is 30,000 tons. The product is low phosphorus pig iron."[163]

10 June 1905. The Iron and Machinery World.

"The Carnegie furnace, Johnson City, Tenn., which has been out of blast for about three weeks, will resume work June 15. J.W. Wingfield, of Cliffton Fords, Va., is working twelve men night and day relining the furnace."[164]

16 August 1906. The Johnson City Comet.

"That furnace that was half completed when the boom collapsed in 1893 has been completed, and is now in full blast. It is making iron from Cranberry mines in North Carolina, which are said to be second in quality to the magnetic ores of Lake Superior. The Watauga tannery is still adding to its plant, and a number of other factories and woodworking plants have located in recent years. These with the Soldiers' Home will insure the future of Cy Lyle's town."

30 November 1906. The Semi-Weekly Messenger (Wilmington, North Carolina).

"Messenger Bureau, Raleigh, N.C., November 27.

The sheriff of Mitchell county was here today and brought two convicts to the penitentiary, both white… Sheriff Smith said that in his entire county there are only 25 negroes. He said further: 'We have never allowed them to live there except a few at Bakersvill and at the Cranberry Mines. I don't think we are much worse off. I think the whole state would find it so.'"

1905 – 1906. Directory of Iron and Steel Works of the United States.

"North Carolina. Blast Furnaces… Cranberry Furnace, Cranberry Iron and Coal Company, Cranberry. One stack, 50 x 11½, built in 1883 – 4. – Dismantled in 1905 – 6."[165]

13 June 1907. The Iron Age.

"The furnace of the Cranberry Furnace Company at Johnson City, Tenn., was blow out for relining May 11."[166]

17 December 1908. The Iron Trade Review.

"The Cranberry Furnace Co., which blew in its stack at Johnson City, Tenn., Nov. 28, had completed some improvements to the plant. The stack had been relined, one of the three stoves had been extended 10 feet higher and an additional stove had been erected."[167]

1908. Directory of Iron and Steel Works of the United States.

"The Cranberry Furnace Company, Johnson City; Philadelphia offices, Drexel Building. One stack, 75 x 16½, partly erected by the Carnegie Iron Company; work suspended in 1892; stack completed in 1898 by the Carnegie Furnace Company and blown in January 2, 1899; three

Whitwell stoves, each 65 x 18; fuel, coke; ore, Cranberry from the company's mines; product, low-phosphorus pig iron; annual capacity, 32,500 tons. Brand, 'Cranberry.' H.M. Howe, President, Alfred D. Pardee, Vice President, and F.P. Howe, Secretary and Treasurer, Philadelphia. Selling agents, Crocker Brothers, New York. (Formerly called Johnson City Furnace and owned by the Virginia Iron, Coal, and Coke Company.)—Active in 1907…"[168]

15 April 1909. Johnson City Comet.

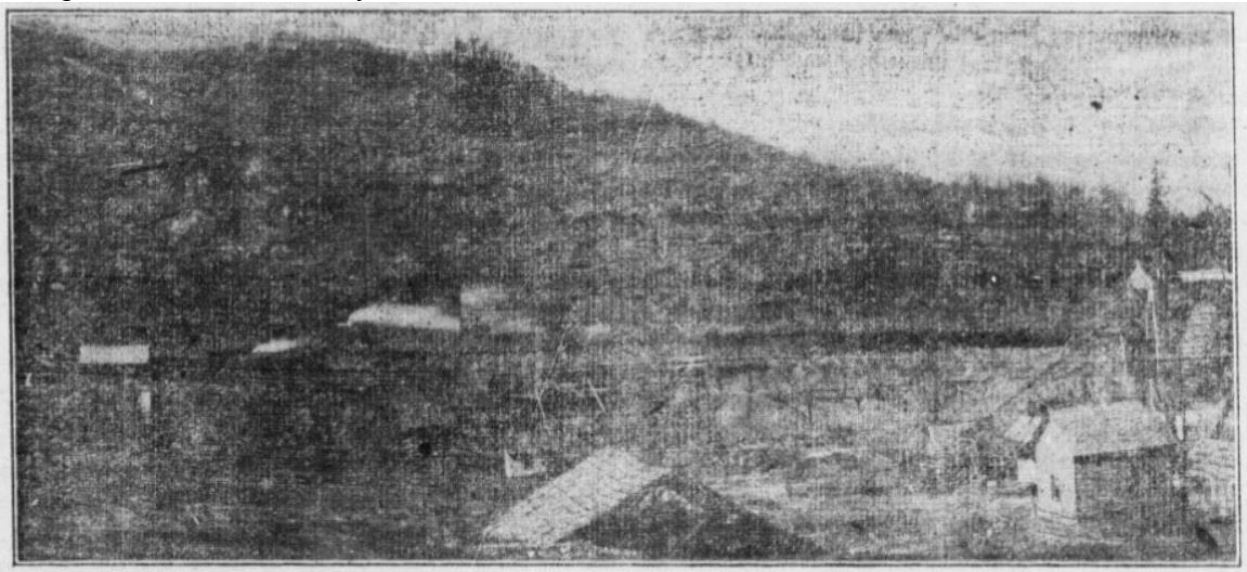


Figure 45. "Magnetic Ore Mines of Cranberry Furnace, at Cranberry, N.C., on E.T. & W.N.C. R.R."
It appears to include an image of the old furnace and its incline on the right of the image.

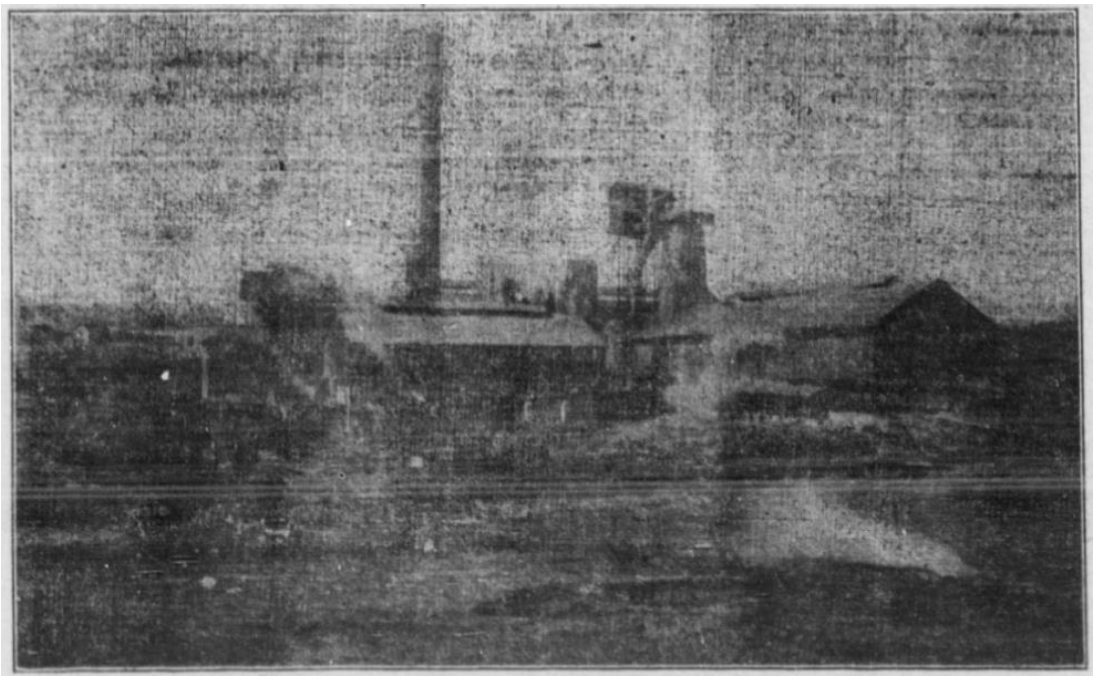


Figure 46. "The Cranberry Furnace, Johnson City, Tenn."

29 April 1909. Watauga Democrat.

"Says the Mitchell County Kronicle: 'Neodaska,' our correspondent at Minneapolis, this county, says that on the evening of the 6th inst., while working in the mines at Cranberry, Will Osborne was killed by a large bowlder falling from the roof… of the mines, crushing his head. Mr. Osbarne was a brother of the late Ike Osborn, who was called out of bed after dark and killed with a shot gun while standing in his door He was also a sun-in-law of the late W.A. Teem, who was killed by the train, at Cranberry about a year ago. Mr. Osborn's wife died about one year ago and left a large family of small children."

1909. Ore Dressing.

"Cranberry Magnet. — At Mill 156 ["Firmstone, Frank, of Easton, Pennsylvania. Private communication."] an interesting magnetic separator is employed in the concentration of magnetic iron ore. This magnet is especially designed for wet work and may be used as a cobbing magnet. As will be seen upon examining the cut (Fig. [47]), the machine consists of a cylindrical drum revolving upon a horizontal axis. This drum is made up of the following parts: (1) shaft; (2) magnet core; (3) magnet body; (4) zinc distance-pieces or rings; (5) a gutta-percha ball pierced to make a water-tight joint for terminal wires; (6) cast-iron sleeves making a water-tight joint; (7) brass rings; and AA', BB', CC', DD', and EE' steel rings constituting magnetic poles. The coils are wound in the spaces between the distance-rings (4) and the magnet body (3), one coil being wound in one direction, the next in the opposite and so on, thus making the steel ring-poles AA', BB', etc., successively north and south magnetic poles. The space between the distance-rings and the periphery of the drum is filled with Portland cement, thus making the drum absolutely water-tight. All the parts are securely bolted together as shown in the illustration, and each coil is separately connected to terminal bolts at one end, for purposes of testing in case a coil burns out.

The material is brought into the magnetic field by means of a belt, when running dry, and may be carried off by a belt running on the drum itself at right angles to the conveyor belt. When running wet the magnetic drum works in a box; the water which washes the material into the box washing away the tailings while the concentrates are removed by a belt passing over the drum. This form of magnet has done very satisfactory work at Mill 156."

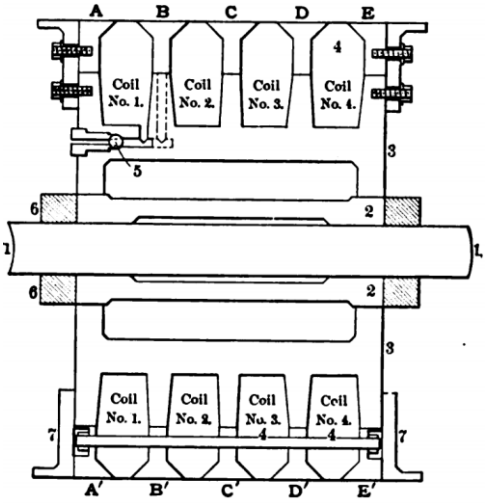


Figure 47. "Cranberry Drum-Type Magnet…"[169]

"Cranberry Mill, Cranberry, North Carolina. — This mill has a capacity of about 350 tons of crude ore in 10 hours ["Firmstone, Frank, of Easton, Pennsylvania. Private communication."]. The economic mineral is magnetite in a gangue composed principally of hornblende, having some epidote and a little quartz and feldspar. The problem is to save the magnetite. Clean coarse rock is supposed to be loaded by itself in the mine and sent to the dump. All other material, including coarse and fines alike, is loaded indiscriminately and sent to (1).

1. Gates breaker, No. 8. with drive pulley making 350 revolutions per minute. A Gates breaker was selected for this position, where it is necessary to handle mixed fine and coarse stuff, because it has little of the tendency to choke which reciprocating breakers show under like treatment. The breaker is kept set up so that as little as possible of ore larger than 3.5-inch cubes is made. The principal use of the lower section of trommel (2) is to keep check on the breaker in this respect. From mine cars; delivers crushed ore to (2).

2. Cylindrical trommel, 2.67 x 14 feet, with 2 sections, the upper having 1.75-inch round holes punched in steel and the lower section having 3.5-inch round holes punched in steel. Makes 18 revolutions per minute and has a slope of 1.5 inches to the foot. From (1); delivers oversize to (4), undersize from the first section to (5), and from the second section to (3).

3. Two cobbing magnets. From (2); deliver magnetic concentrates to coarse-ore pocket and non-magnetic and lean tailings to (4).

4. Gates breaker, No. 3, breaking through a 1.75-inch round hole and the drive pulley making 425 revolutions per minute. From (2) and (3); delivers crushed ore to (5).

5. Two double log washers. From (2) and (4); deliver clean washed ore to (6) and washer-tailings to the dump. These tailings carry nothing worth saving except a small amount of very fine magnetite. This magnetite would probably pass a 40 or 50 mesh and is carried off in the muddy water.

6. Two trommels making 14 revolutions per minute and having slopes of 1 inch to the foot. Each trommel consists of 3 concentric conical screens. The inner screens have 1.25-inch round holes, the middle screens have 0.625inch round holes, and the outer screens have oblong holes, 0.375 x 0.1875 inch. From (5); deliver oversize on coarse screens to (7), oversize on middle screens to (8), oversize on outer screens to (9), and undersize of outer screens to (10).

7. Two coarse magnets. From (6); deliver magnetic concentrates to cars and non-magnetic and lean tailings to (11).

8. Two Cranberry magnets. From (6); deliver magnetic concentrates to cars and non-magnetic and lean tailings to (13).

9. Wet magnet. From (6); delivers magnetic concentrates to cars and non-magnetic tailings, via launder, to dump.

10. Wet magnet. From (6); delivers magnetic concentrates to cars and non-magnetic tailings, via launder, to dump.

11. Conveyor. From (7); delivers to (12).

12. Coarse-tailings magnet. From (11); delivers magnetic concentrates to cars and non-magnetic tailings to dump.

13. Magnet for re-treating tailings. From (8); delivers magnetic concentrates to cars and non-magnetic tailings to dump.

The mill operates one 10-hour shift per day for 6 days a week, and yields about 240 tons of concentrates per 10 hours…"[170]

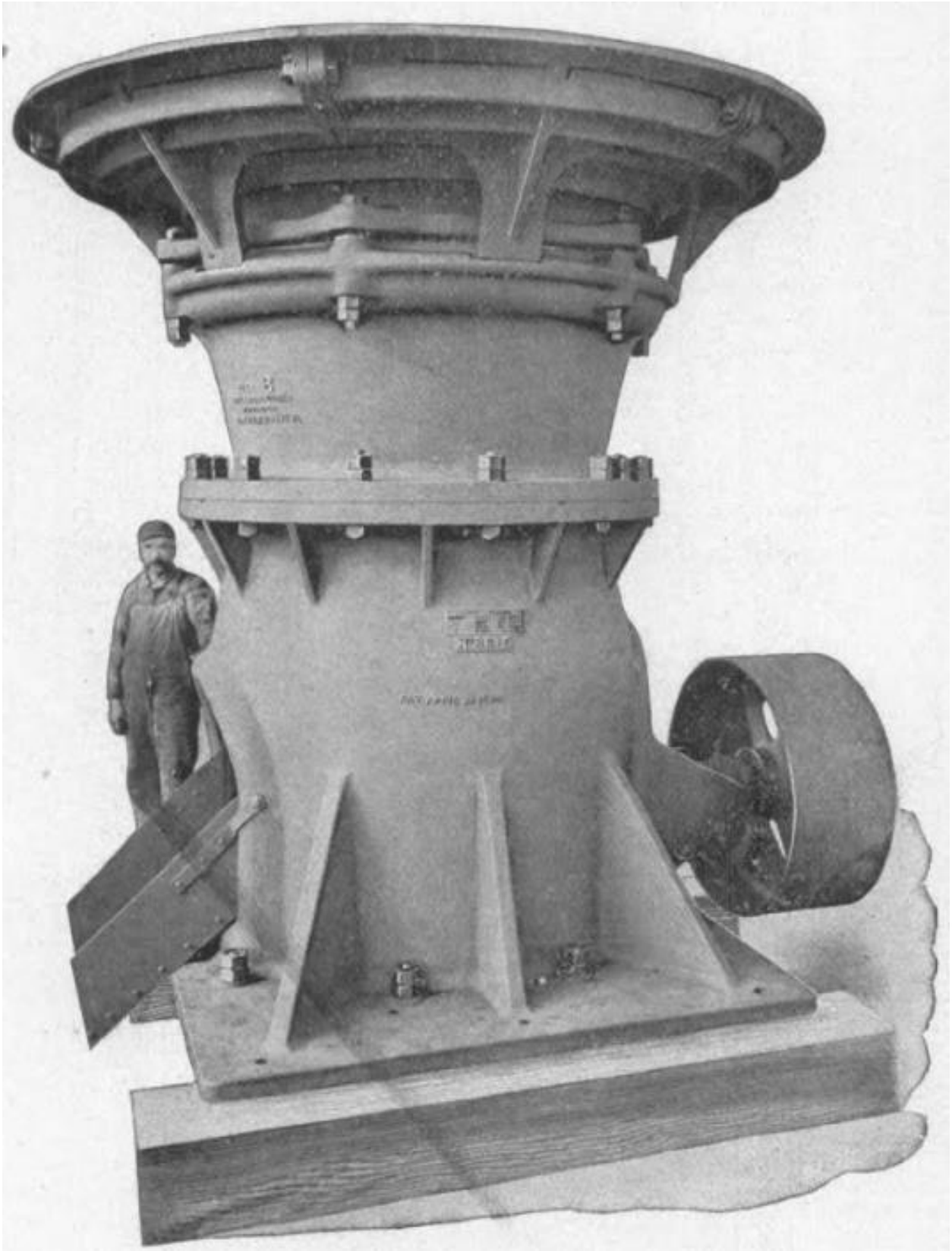


Figure 48. “Gates’ Ore Crusher.”[171]

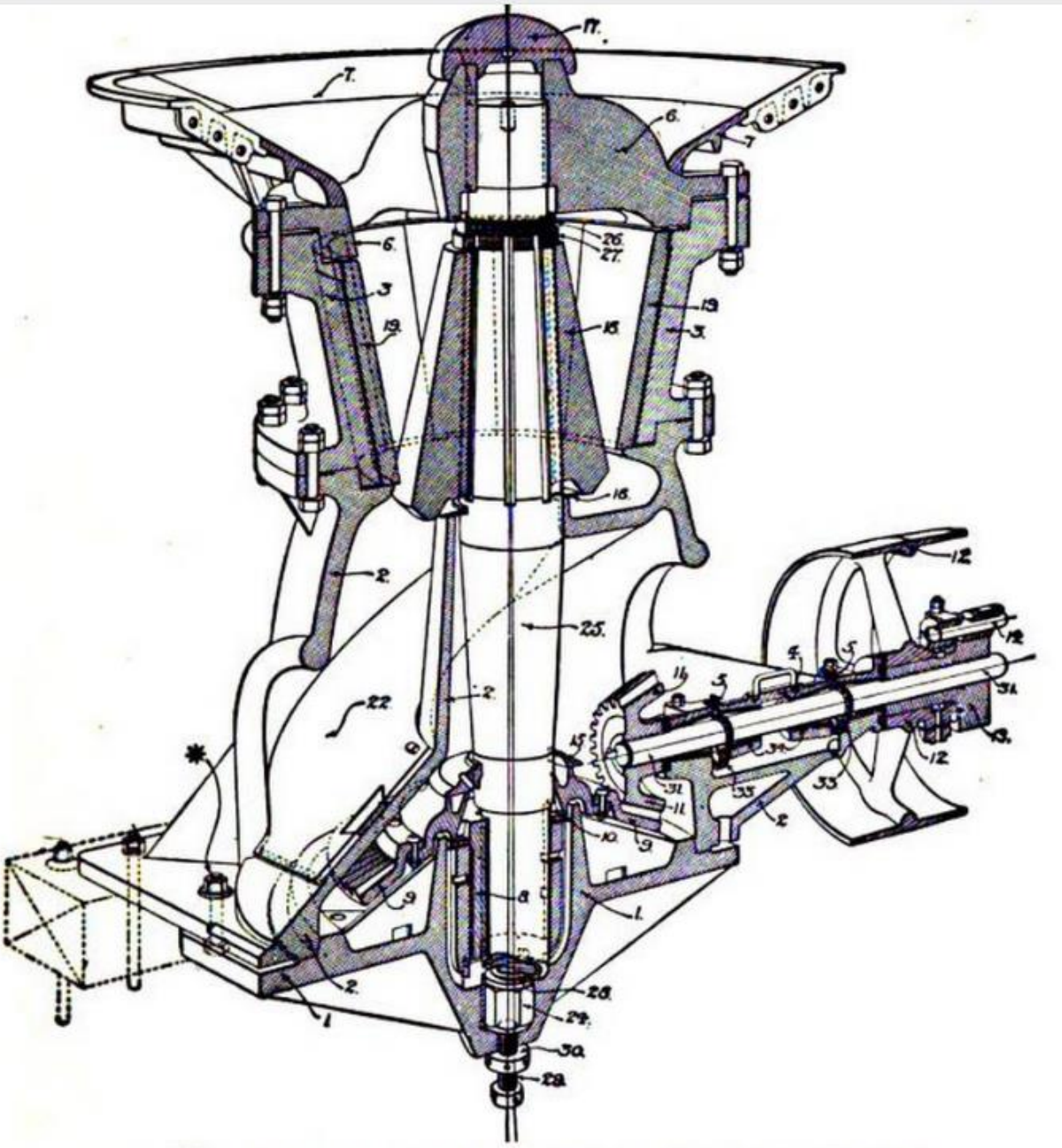


FIG. 25.—SECTIONAL PERSPECTIVE VIEW OF GATES BRFAKER.

1. Bottom plate.
2. Bottom shell.
3. Top shell.
4. Bearing cap.
5. Oil cellar cap.
6. Spider.
7. Hopper.
8. Eccentric.
9. Bevel wheel.
10. Wearing ring.
11. Bevel pinion.
12. Pulley.
13. Break-pin hub.
14. Break-pin.
15. Oil bonnet.
16. Dust ring.
17. Dust cap.
18. Head.
19. Concaves.
22. Chilled wearing plates.
24. Octagon step.
25. Spindle.
26. Upper ring nut.
27. Lower ring nut.
28. Steel step.
29. Lighter screw.
30. Lighter screw jam nut.
31. Counter shaft.
33. Oiling chain.

Figure 48a. "Gates' Ore Crusher."[172]

The "No. 8 breaker of the Gates Iron Works, Chicago… weighs 90,000 lbs.; its guaranteed output of 125 tons of ore an hour. The power required to operate it is about 125 h.p."[173]

Extract "Details of Gates Breaker. (Taken from the Catalogue.)

Size.	Weight of breaker, pounds	Capacity per 24 hours in tons of 2,000 pounds passing 2½ ring according to character of rock	Dimensions of driving pulley, inches.		Revolutions of driving pulley per minute.	Indicated horsepower of engine recommended to drive breaker, elevator and screen.†	Price.
			Diameter.	Face.			
00	350		8	2 5/8	700	1 to 1½	$100
0	3,000	48 to 96	16	6	500	4 [to] 5	375
1	5,500	96 [to] 192	20	7	475	8 [to] 10	550
2	8,000	144 [to] 288	24	8	450	12 [to] 15	760
3	14,000	240 [to] 480	28	10	425	20 [to] 25	1,200
4	21,000	360 [to] 720	32	12	400	25 [to] 30	1,800
5	29,000	600 [to] 960	36	14	375	30 [to] 40	2,500
6	40,000	720 [to] 1,440	40	16	350	40 [to] 60	3,300
7½	61,000	1,200 [to] 3,000	44	18	350	75 [to] 125	5,000
8	90,000	2,400 [to] 3,600	48	20	350	125 [to] 150	7,00

† This is a general figure. For fine crushing the capacity will be less and the power greater."

January 1910. "The Concentration of Magnetic Iron Ores," by N.V. Hansell.

The Wenström Separators are "still used in the United States at Cranberry, N.C."[174]

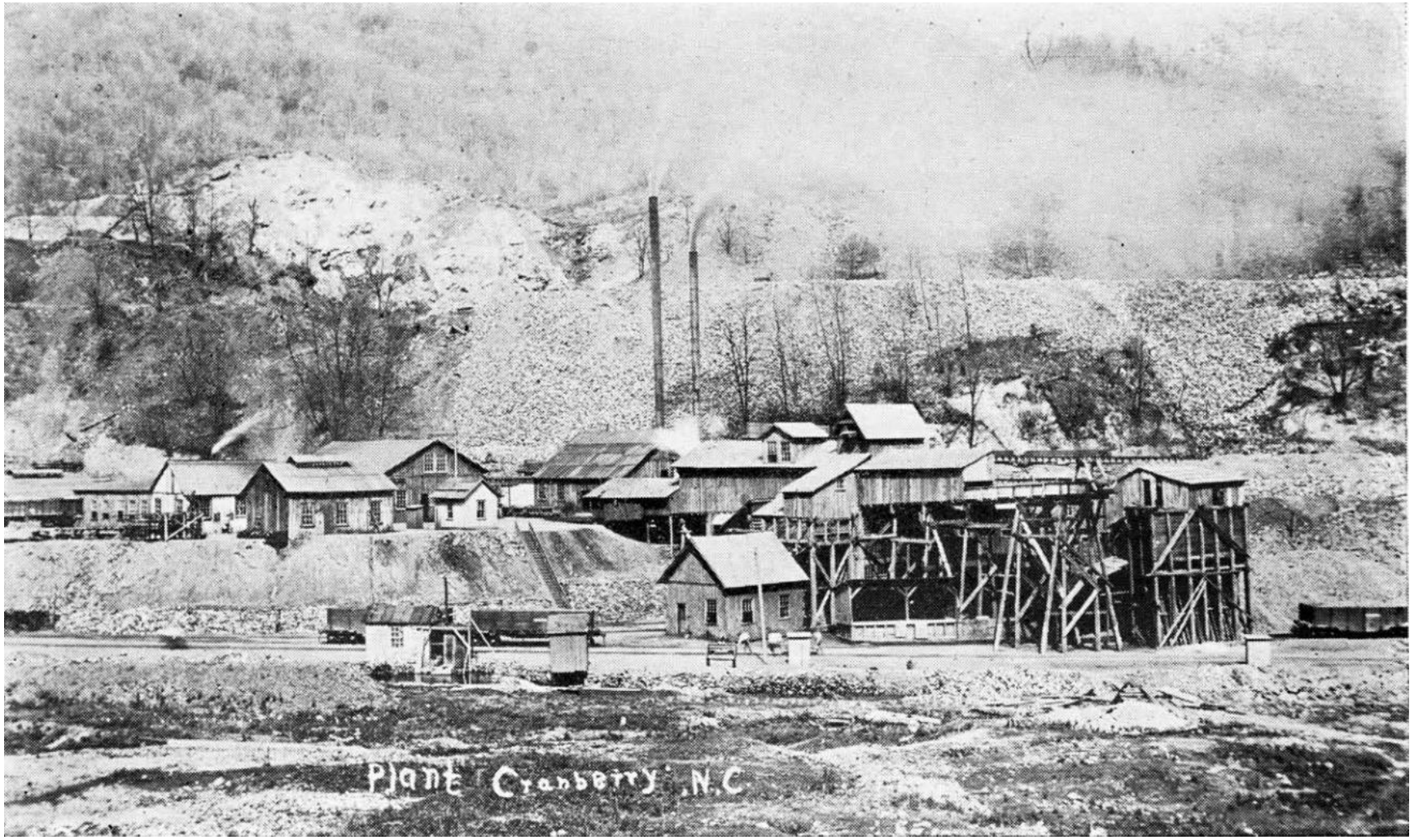


Figure 49. “Mines and Plant of Cranberry, N.C.” “Photo by J.W. McCracken” “The photo on this postcard was taken from the same vantage point as the photo to the right [Figure 61], but years earlier. The layout of the mine buildings before World War I was very similar to the later configuration with a few notable exceptions, and these help to date photos of the mine. The boiler house (center) in this photo has only two stacks and in only one-story tall. There’s also fewer ore chutes and slides on the bank of tailings behind the mine buildings. Postcard courtesy of the North Carolina Collection of the University of North Carolina at Chapel Hill.” Note: the boiler house has only two smokestacks, indicating that this photo probably predates 1911, Chris Ford dates it to 1905.[175]

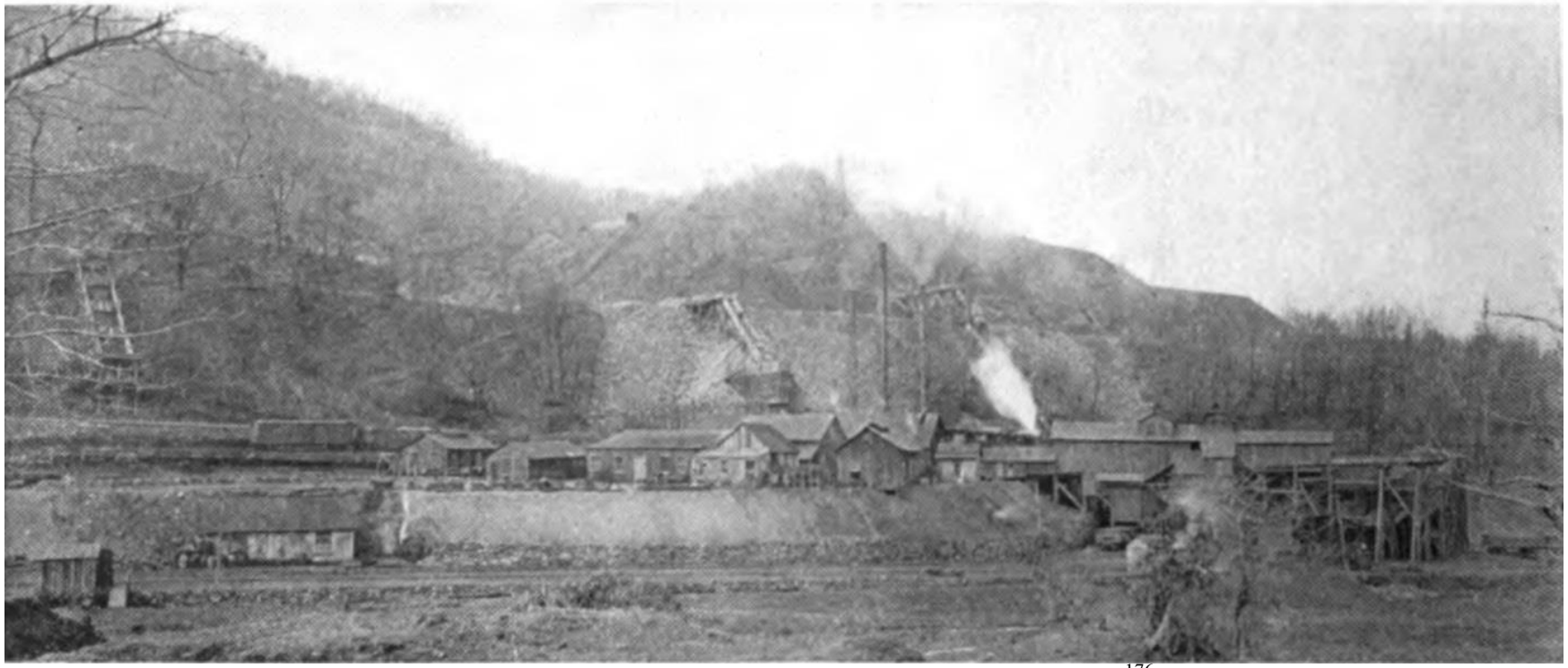


Figure 50. “The Cranberry Furnace Company’s surface plant.”[176]

May 1911. "The Cranberry Mine, Methods at a North Carolina Iron Ore Property," by B.C. Hodgson [Knoxville, Tennessee]

"The mine of the Cranberry Furnace Company is situated at Cranberry, North Carolina, in the northern part of Mitchell County, on one of the eastern slopes of the Smoky Mountain range. The company, or its parent corporation, the Cranberry Iron & Coal Co., owns some 4,000 acres in this vicinity. Ore from the mine is concentrated at Cranberry and shipped to the company's furnaces at Johnson City, Tennessee, 34 miles distant, over the East Tenn. & Western N.C.R.R…

Geology

The ore deposit is in the form of a large lens, whose limits have not been fully determined. It consists of a high grade of magnetite, associated with pyeorene epidote, quartz, feldspar, calcite, garnet, and other minerals. Its low content of phosphorus renders it a very desirable ore for all uses. It varies in character, some parts of the deposit being fine grained, massive and dense, and others soft, coarse, and granular. This latter is known locally as 'rattlesnake' ore, from the diamond-shaped marking of the granular accretions. The deposit is a vast body of ore and rock, with the ore scattered promiscuously through it, in varying purity, but usually in the form of bands or lenses. The thickness of these bands varies from a few inches to 70 feet or more. The highest outcrop on the ridge is about 400 feet above the water level of Cranberry Creek. [Figure 50] shows a general view of the mine openings at the three levels on the side of the ridge, together with the concentrating plant, power house, and ore chutes.

History

The Cranberry iron ore deposits are much the most important in North Carolina. The value of the ore was understood as early as 1820 or 1825, when it was worked in a small way in catalan forges. The quality of the iron from these forges attracted much attention. In 1866 it was tested in the Naval ordnance yards at Washington with satisfactory results.

The owners of the forges merely stripped off the loose friable surface ore, and for many years further development was retarded by lack of funds. About 1875 the property came into the hands of the present owners, who have developed a body of ore that is on a par, in extent and quality, with the Lake Champlain and New Jersey deposits.

Mining Methods: Upper Level

The mine is operated from three main and several sub-levels. From the upper level, at almost the top of the outcrop, 350 feet above the creek, three slopes are being sunk in and with the ore body at an angle of 38 degrees. These slopes have been advanced about 150 feet. This band of ore is 20 feet thick at the outcrop and has been shown by diamond drilling to attain a thickness of 70 feet, at a point 400 feet in from the surface, measured along the dip.

The ore is drawn up these slopes by separate hoisting engines, in end dump cars of 3,000 pounds capacity. The cars are then run to the gravity incline [figure 51]… on which they descend to the second or open cut level. Here the ore is dumped through a chute 80 feet long into bins on the lowest or main tunnel level. The gravity incline is 145 feet in height and 275 feet long."

Figure 51. “Gravity incline and entrance to slopes on open cut level.”

"Open Cut Level

Until three years ago this part of the mine was worked only as an open cut. So much rock was encountered, however, in the face of the workings, that this method was abandoned and tunneling and drifting substituted. (See [Figure 52]) The distance across the open cut floor from the foot wall to the hanging wall is 400 feet."

Figure 52. "The open cut level."

"Tunnel Level

The main tunnel has attained a distance from the surface of about 450 feet. There are several large workings on this level. Three slopes have been sunk from it at an angle of about 30 degrees, to a depth of about 400 feet in the ore body. From these slopes drifts to right and left are turned, and on the drifts large stopes have been opened. These stopes frequently attain a vertical height of 70 feet, all in ore. Crews of men are regularly employed to mount on ladders to the tops of these chambers and pick down the loose fragments from the roof and walls, after a blast, in order to protect the miners below. Some idea of the height and area of these great chambers will be obtained from [Figure 53], taken on the tunnel level.

From the main tunnel level a drift is being extended to intercept slope No. 2 from the upper level. The vertical distance from the floor of this drift to the floor of the upper level is 225 feet. A second drift, on a level 60 feet below the first, is being sunk in the same ore body, and will eventually intercept the No. 2 slope at a distance from the surface of about 1,800 feet."

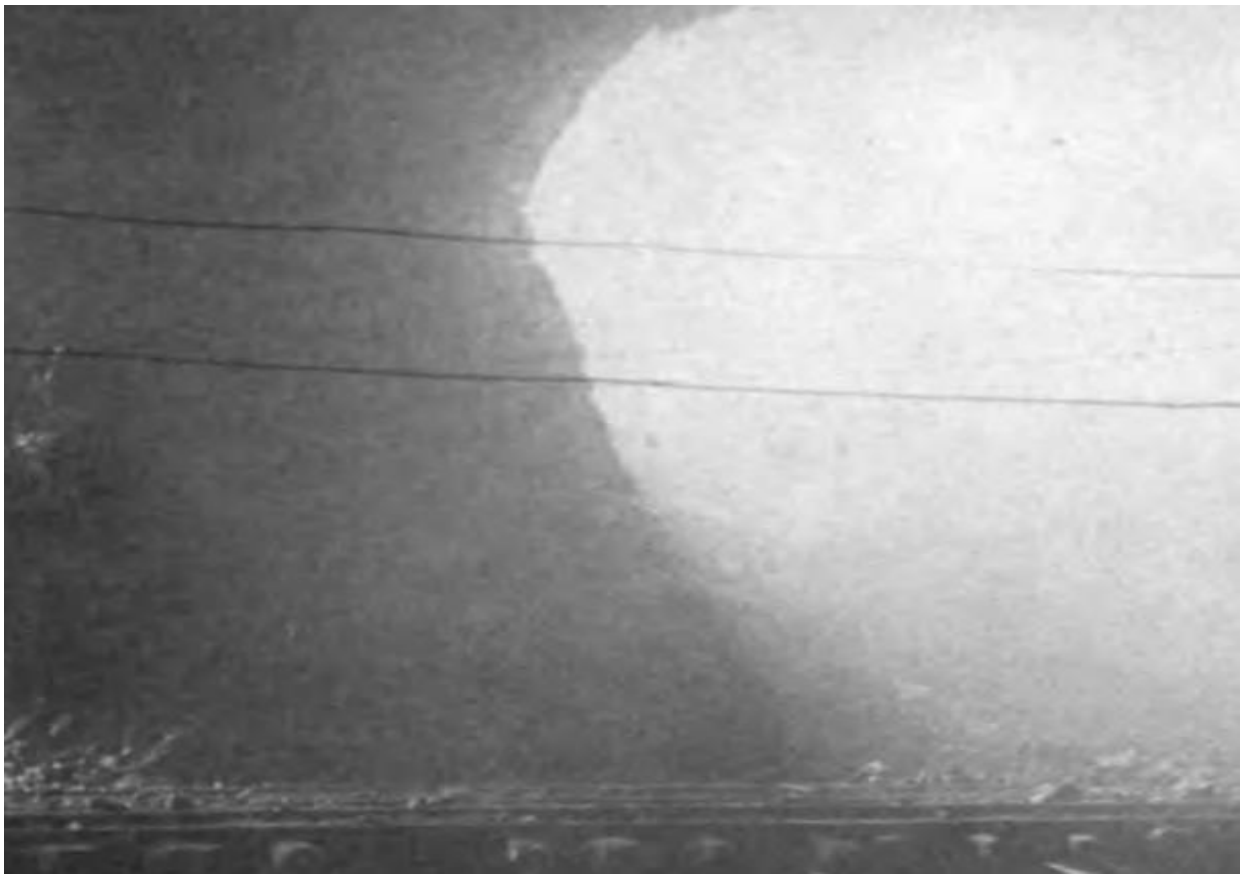


Figure 53. “A room or stope in the Cranberry mine.”

“Ground Breaking

About 30 standard piston rock drills of 3 1/8 and 3¼-inch cylinder diameter are employed for breaking ground. These drills are mounted on tripods or mining columns and are driven by compressed air at 90 pounds receiver pressure. The ample size of the pipe lines and their careful arrangement and maintenance render pressure losses very small. Air re-heaters, burning coal, insure dry air at the drills and further minimize transmission losses. Both the rock and the ore itself are very hard, rendering the drilling slow and throwing a heavy burden on the drills. In recent diamond drill prospecting, the average progress was ten feet per ten— hour shift, but for much of the work only two feet per shift could be drilled. This will give an idea of the severity of the drilling conditions.

Drill Maintenance

The cost of drill maintenance resulting from this difficult ground induced the mine officials to conduct very thorough tests on different kinds of drills. This investigation resulted in the adoption of the Sullivan 3¼-inch tappet valve drills, which gave the best results in drilling speed and in repair costs per foot. Since these drills were put in, nearly two years ago, there has been a noteworthy reduction in maintenance charges, and an increase in the amount of ground broken per drill. The average drilling speed in this mine is about six feet per hour, or 30 to 40 feet per ten-hour day, including setting up, tearing down, and moving the drills. The ore is removed in benches, from 15 to 70 feet high, and the average depth of holes drilled is eight feet.

Mr. J.M. Cameron, general superintendent of the company, has designed an automatic lubricator which is used on all the drills at this mine and has maintained their efficiency at a high level. The oil chamber is so arranged that the oil is under air pressure, the pressure above the surface of the oil being about 15 pounds in excess of that at the discharge opening. This results in injecting a small quantity of oil into the cylinder at every stroke, and thus keeps the drill properly and positively lubricated at all times.

Haulage

The main tunnel level is equipped with a system of tracks serving all parts of the mine. The ore from the two upper levels as noted above, is dumped into bins, and thence into mine cars. These cars run by gravity, in trips of five, to an incline, up which they are hauled by a cable and dumped directly into the crushers. The empty cars are hauled back into the mine by mules. The track gauge is 36 inches and the car holds 3000 pounds of ore.

Ventilation and Drainage

No artificial ventilation is required. The mine makes but little water in any of its workings, and is kept dry by a pump of 200 gallons capacity, running less than half time. These conditions render labor conditions much more agreeable than usual in a mine of this size and character.

Concentration

The concentrating plant is directly at the entrance of the mine, (see cut below). The ore is first crushed by two gyratory crushers, with the usual equipment of screens, washers, and conveyors. The ore is screened into five sizes: 3½-inch or 'cobbed' ore, l½-inch, l 1/8-inch, and 5/8-inch and 'dust.' The crushed ore is separated from the waste rock by passing it over electro-magnets, of which ten are in use. These magnets were designed by Mr. Frank Firmstone, a director of the Cranberry Furnace Co. They are of the revolving pattern, with a belt on which the ore is carried over them. These magnets have proven very efficient, and cost little to maintain. Some have been running for upwards of four years without any repairs.

The '5/8-inch' and 'dust' sizes are carried to the separator by water and the ore is lifted from the water by the half submerged magnets. The ore is run either to bins or directly into railroad cars which carry it to the company's furnaces at Johnson City, Tenn…

Power Plant

The power plant consists of 500 horsepower boilers which operate the compressor and engines, a 2000 cubic feet cross compound two-stage air compressor, one 80 horse-power Corliss engine, which drives the crusher, magnets, etc., etc., in the concentrating plant, and a 50 horsepower engine which drives the dynamo for the electro-magnets and the lights in the plant and mine. There are well-equipped carpenter, machine and blacksmith shops. The company builds its own mine cars.

The village of Cranberry has a population of about 600, of whom one-half are miners. There is a church, a school, hotel and a large company commissary. Good water is available, and the climate and sanitary conditions are excellent.

Aid in preparing this article is acknowledged to Mr. J.M. Cameron, superintendent and to Bulletin No. 1 of the North Carolina Geological Survey."[177]

Figure 54. “Concentrator, Cranberry Furnace Co.”[178]

August 1911. “The Cranberry Iron Ore Mine, Large Deposit of High-Grade Magnetite, Methods of Mining and Electric Concentrating,” By J.M. Cameron.[179]

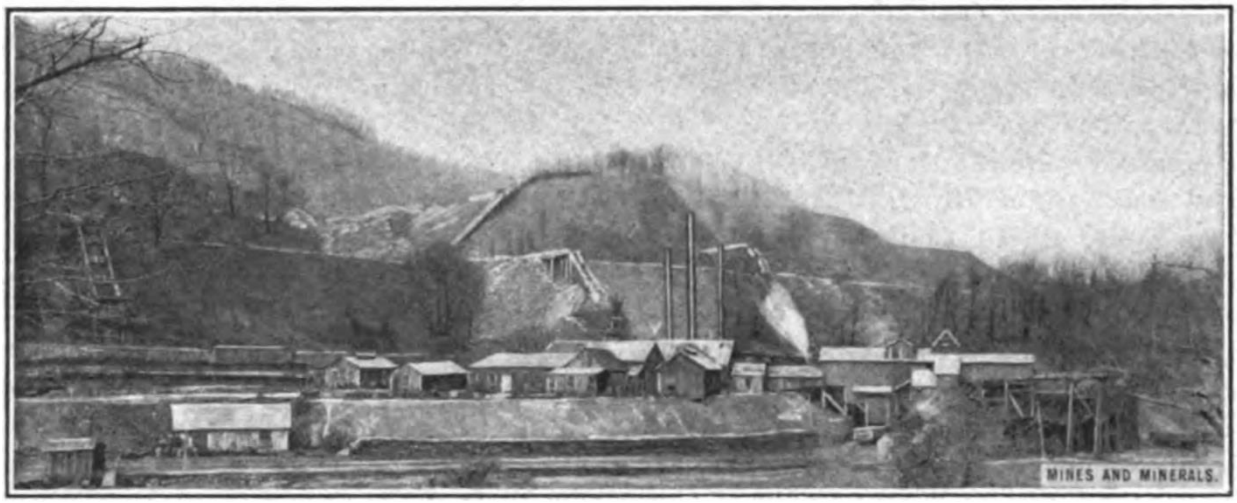


Figure 55. “Cranberry Iron Mine”

“In 1887, W.C. Kerr and G.B. Hanna of the Geological Survey of North Carolina, wrote a book entitled ‘The Ores of North Carolina’ in this a short description of the Cranberry ore bank will be found. In the May, 1911, issue of Mine and Quarry there is a descriptive article on the Cranberry mine by B.C. Hodgson, from which much of this article has been abstracted.

The Cranberry iron ore deposit is formed by an aggregation of magnetite crystals cemented together so as to form an almost pure mineral mass. Magnetite, Fe_3O_4 when chemically pure, contains 72.4 per cent. iron and 27.6 per cent. oxygen; as found in magnetic form, however, the iron analysis is not likely to exceed 70 per cent. Of the two analyses given, No. 1 was made by the late Professor Genth, of Philadelphia, and No. 2 by the late Professor Chandler, of New York City. From the analyses furnished, the writer is inclined to the belief that they were made from picked samples and not run-of-mine or shipping ore.

Cranberry ore bank, which is on the western slope of Iron Mountain, in the northeastern part of Mitchell County, N.C., receives its name from Cranberry Creek, which flows at the foot of the steep hills on which it outcrops. It is owned by the Cranberry Iron and Coal Co., who mine and ship it to their furnaces at Johnson City, which is 34 miles distant.

The ore deposit is in the form of a large lense whose length and depth are not fully known. The gangue minerals are pyroxene, epidote, quartz, feldspar, and garnet, with occasionally other minerals of a common kind. It is now the generally accepted belief that the magnetite deposits of the Appalachian Mountains crystallized from the magmas of which they formed a part. The isometric crystals, when small, formed a hard compact mass, but when large the mass had less cohesion, and on account of the diamond-shaped crystal faces it presents, it is locally termed ‘rattlesnake ore.’ The magnetite is associated with epidote and feldspar, which form horses in the deposit and decrease its purity; usually, however, it is in lenticular masses whose greatest lengths are along strike, and these are the chief sources of ore. The thickness of the ore lenses varies from a few inches to 70 feet.

Analyses of Cranberry Ores

	No. 1	No. 2
Magnetite Fe_3O_4	94.37	91.83
Magnesia MgO	.36	.23
Alumina Al_2O3	.42	1.03
Lime CaO	.43	1.06
Manganese oxide MnO_2	.26	.32
Water		1.15
Silica SiO_2	4.16	4.02
Sulphur S		.25
Phosphoric acid P_2O_5		

The country rock is gneiss in contact with syenite; the ore zone, however, is confined within the gneiss. The normal strike of ore beds in the Appalachian Mountains is northeast and southwest, and as the Cranberry bed strikes northwest and southeast it would indicate that it had been subjected to faulting, and this probably accounts for the deposit being cut out by rock in a southeasterly and narrowed in a northwesterly direction. A general idea of conditions prevailing at the Cranberry mine can be had from Fig. [55]. At the outcrops on the top of the hill the deposit is approximately 400 feet wide between the foot-wall and hanging wall, and has an average dip of 34 degrees. The top 80 feet of the deposit was worked as an open-cut mine until drift and stope mining was substituted to avoid handling horses of rock. In order to reach the ore at the level of the valley a tunnel was driven about 450 feet in length. On reaching the ore the drift was continued to the right in a northerly direction 350 feet to the foot-wall. The drift was made large, and from it stopes were worked up to the open cut above, thus allowing daylight to shine into the lower or main level. A good idea of the height of one of these stopes can be obtained from the pillars, shown in Fig. [56], and the hole in the upper right-hand corner through which daylight shines. On the main level there are several parallel tracks which serve the rooms on this level and the three slopes put down from this to a level below. Underhand stoping is practiced, and as the rooms are formed care is taken to secure such shape to the roof that when once finished it will remain safe indefinitely. After each blast a force of men termed ‘scalers’ work from the top of the stope, pull down or break if necessary any pieces of ore likely to come loose in time, and thus make the roof safe. As the drills are always advancing the stope room, the roof is usually left in safe condition. Occasionally, however, in some part the roof of one of the large rooms will need attention, and it is reached then by specially constructed ladders, or other means are devised by the scalers.

The three slopes sunk from the main level to the lower level are inclined at 30 degrees and have a length of about 400 feet. From these slopes, levels are driven right and left on the strike of the ore at intervals, and after any one of the levels has been advanced a sufficient distance a room is turned and by underhand stoping driven to the level above. Between adjacent rooms a pillar of ore shaped like an hour glass, as in Fig. [56], is left standing to support the cover, and as that is not heavy, a small pillar of strong ore is sufficient.”

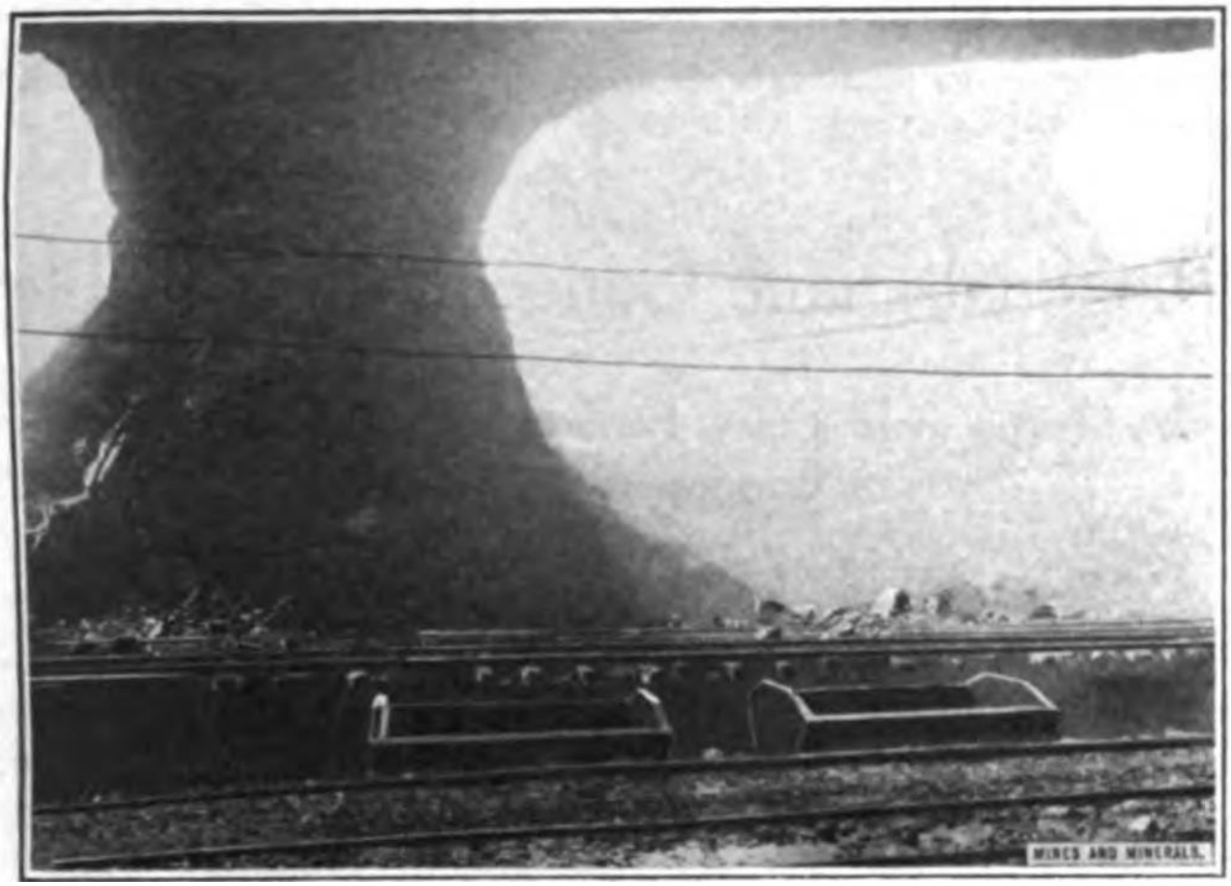


Figure 56. “Pillars in Cranberry Mine”

“The open-cut level shown in Fig. [57] is approximately 100 feet higher than the main level. In the face of ore left after open-cut work was abandoned, levels have been driven, as shown, and rooms opened as on the other levels. In Fig. [57] an opening resulting from working upwards from the main level is seen, and this is now used as a chute for ore from the upper to the main level. The floor of the open cut, which has been stated as having been 400 feet from foot-wall to hanging wall, is also shown. During the time open-cut mining was followed the ore was loaded into cars and dumped into the chute shown in Fig. [55], and thus lowered to the ore bins.”

Figure 57 “Open-Cut Level”

“Entirely separate from and 200 feet above the floor of the open-cut mine is another outcrop of magnetite. This deposit is separated from the other by a horse of rock which does not Pass through, although it enters the ore, for which reason the upper deposit is presumed to be part of the lower. Three slopes having a pitch of 38 degrees have been sunk on the upper deposit to a depth of 150 feet, only one of them, No. 2, will be continued, the other having been sunk to quickly open working places. At present the ore is hauled up these slopes by hoisting engines in end-dump cars having a capacity of 3,000 pounds. The cars are then run to the gravity plane shown in Fig. [55], but better shown in Fig. [58], and lowered to the open-cut level. Here the ore is dumped into a chute 80 feet long through which it slides into bins on the main level. The inclined plane from the upper deposit to the open-cut level is 275 feet long and has a perpendicular height of 145 feet, or a ratio of 1/1.89. At the top level, which is almost to the outcrop, the ore is 20 feet thick, but at a depth of 400 feet measured along the dip the diamond drill core shows it attains a thickness of 70 feet. The main, or No. 2 slope, of the top or outcrop level is being sunk on the true dip of the ore, and another starting from the main, or tunnel level in the northwest corner of the old mine, is being sunk in the ore, with a view of eventually intersecting the No. 2 slope when the latter has reached a length of 1,800 feet.”

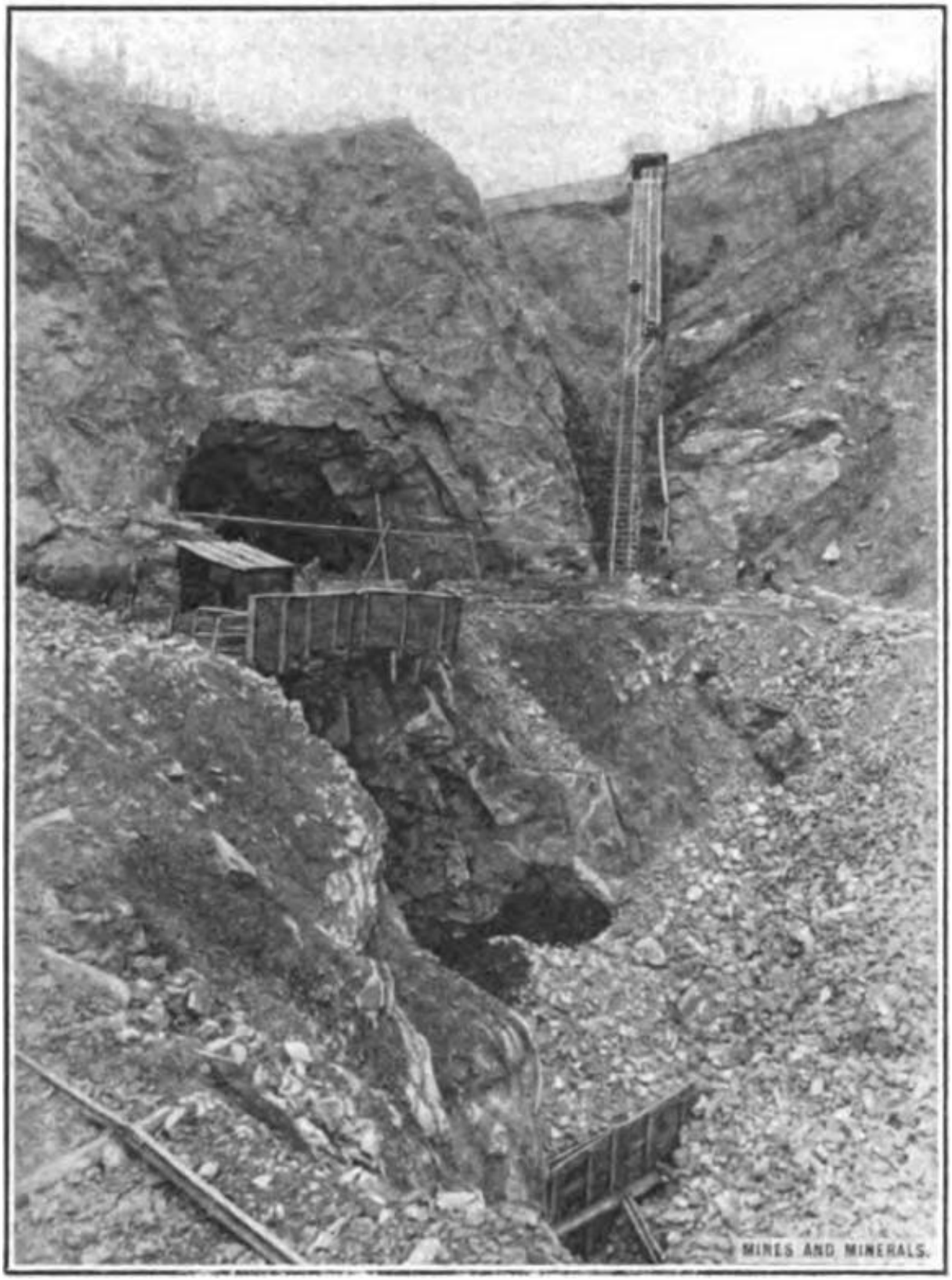


Figure 58. “Incline from Upper Deposit”

"About 30 standard piston rock drills of 3 1/8 and 3¼-inch cylinder diameter are employed for breaking ground. These drills are mounted on tripods, or mining columns, and are driven by compressed air at 90 pounds receiver pressure. The ample size of the pipe lines and their careful arrangement and maintenance render pressure losses very small. Air reheaters, burning coal, insure dry air at the drills, and further minimize transmission losses. Both the rock and the ore itself are very hard, rendering the drilling slow and throwing a heavy burden on the drills. In recent diamond-drill prospecting, the average progress was 10 feet per 10-hour shift, but for much of the work only 2 feet per shift could be drilled. This will give an idea of the severity of the drilling conditions.

Drill Maintenance—The cost of drill maintenance resulting from this difficult ground induced the mine officials to conduct very thorough tests on different kinds of drills. This investigation resulted in the adoption of the Sullivan 3¼-inch tappet valve drills, which gave the best results in drilling speed and in repair costs per foot. Since these drills were put in, nearly 2 years ago, there has been a noteworthy reduction in maintenance charges, and an increase in the amount of ground broken per drill. The average drilling speed in this mine is about 6 feet per hour, or 30 to 40 feet per 10-hour day, including setting up, tearing down, and moving the drills. The ore is removed in benches, from 15 to 70 feet high, and the average depth of holes drilled is 8 feet.

The writer, when general superintendent of the company, designed an automatic lubricator which is used on all the drills at this mine and has maintained their efficiency at a high level. The oil chamber is so arranged that the oil is under air pressure, the pressure above the surface of the oil being about 15 pounds in excess of that at the discharge opening. This results in injecting a small quantity of oil into the cylinder at every stroke, and thus keeps the drill properly and positively lubricated at all times.

Ventilation and Drainage—No artificial ventilation is required. The mine makes but little water in any of its workings, and is kept dry by a pump of 200 gallons capacity, running less than half time. These conditions render labor conditions much more agreeable than usual in a mine of this size and character.

About 25 years ago there was a small charcoal iron furnace in operation at Cranberry. The ore for this furnace was taken almost entirely from the surface outcroppings. Only the choice lump ore was used. The ore at or near the surface, being 'weathered,' crumbled easily into small particles. Practically all of the fine ore was thrown out with the waste rock and clay. As this went on for a number of years, there accumulated thousands of tons of dump material containing large quantities of ore in fine particles. About a year ago an investigation was made of the quality of these old dumps, with the result that they are now being worked. About 150 tons of this old dump material is being sent daily direct to the furnace, and about 75 tons of it is sent daily to the concentrating plant, making a total of about 225 tons of ore per day taken out of the dumps that but a few years ago were considered as having no value. The ore taken from these dumps and sent direct to the furnace averages about 40 per cent. in iron, has practically no sulphur, and less than .01 of 1 per cent. phosphorus.

The ore is transferred from the mines to the concentrating plant in trips of five cars, each car carrying 3,000 pounds of crude ore. Cars, as they reach the first crusher, are run into a cylindrical cage that, rolling sideways on a track, turns the mine car bottom up, dumping the contents into the crusher hopper. The crusher is a No. 5 Gates gyratory and discharges directly into a 32" x 16' revolving screen, in which the ore first passes over holes 1½ inches in diameter; the coarse ore then passes over holes 3½ inches in diameter; the 1½-inch size goes from the

screen to the washers; the 3½-inch size goes from the screen to 'cobbing magnets.' From these magnets the heads go direct to the loading bin, and the tails go to a smaller crusher. A feature in use at the cobbing magnets is worthy of note: the speed of these magnets is such that dead stock is thrown off by centrifugal force, and many tons of rock are in this way disposed of that would otherwise have passed through the smaller crusher. After leaving the washers the material is screened into four sizes; first, that which will not pass through a 1 1/8-inch hole; second, that which, having passed through a 1 1/8-inch hole, will not pass through a 5/8-inch hole; third, that which, having passed through a 5/8-inch hole, will not pass through a 3/16" x ½" hole; and fourth, that which passes through 3/16" x ½" hole. These several sizes are known, respectively, as 'coarse concentrate,' 'fine concentrate,' '5/8-inch concentrate," and 'dust concentrate.' On leaving the screens, the coarse and fine concentrates pass over a series of revolving magnets, while the fine and dust concentrates are carried with a stream of water to magnets that revolve in a water-tight box and pick the ore up out of the water.

The magnets in use at the Cranberry concentrating plant are of the revolving cylindrical type. Each magnet has four poles, and carries about 10,000 feet of No. 11 copper wire. The voltage used is 125. Each magnet has attached a suitable rheostat, and the current varies from 4 to 10 amperes per magnet. In operation the current passing through the several magnets is closely watched and readings are taken twice in each 10 hours. When the crude ore coming from the mines carries an excess of phosphorus, the current on magnets is weakened, and there is a greater or less loss in consequence of the tails being richer. When the phosphorus in the crude ore is low, the strength of the magnets is increased; the tails are then proportionately leaner. While the Cranberry iron ore is noted for its small percentage of phosphorus, yet the uniformity and excellence of the product from these mines is largely due to the equipment at the concentrating plant and the care taken in the work of concentration.

The electromagnets in use at this plant are extremely simple, and when properly wired and insulated, run for years without any repairs whatever. The tailing leaving the final magnets averages about 16 per cent. iron. Of this about 8 per cent. is insoluble. When it is remembered that there is no fine crushing of the ore, no rolls being used in this plant, it will be seen that the results obtained are exceptionally good.

The machinery of the concentrating plant is at such an elevation that the magnets discharge directly on to railroad cars beneath the plant. The cars for the 'heads' being on one track and the cars for the 'tails' being on another track. This arrangement is not entirely satisfactory, as there is difficulty at times, particularly in cold or stormy weather, in getting the cars to follow each other in such order as will not delay the work of the plant. On the whole, however, this concentrating plant gives good results, both as to the quality of product and economy in operation."[180]

29 June 1911. Johnson City Comet.

"Elk Park News. From Avery Vim… A shocking accident occurred in the Cranberry iron-ore mines last Saturday afternoon, resulting in the death of L.C. Tolley, aged 24 years. While at work with his machine, Mr. Tolley's drill unexpectedly struck a loaded hole, causing an explosion which blew his mangled body about twenty feet and tore off the whole upper part of his head. Internment in the Elk Park cemetery. Mrs. Tolley has since moved back to the home of her father, C.G. Cook."

20 July 1911. The French Broad Hustler (Hendersonville, North Carolina).

"Mine Disaster in Avery First in Old North State. The first serious mine, accident in North Carolina during many years was that recently occurring at the Cranberry mines in the new county of Avery. It resulted in the instant and horrible death of L.C. Tolley and the injury of Penn Tolley, with whom he was working.

Commissioner of Labor M.L. Shipman, who is also State Mine Inspector, has just completed a thorough investigation of the accident and its causes and, also of the, mine itself. Mr. Shipman, on his return from Cranberry to Raleigh, spent Sunday here. He talked interestingly of the North Carolina industry of iron ore mining.

Mr. Shipman said:

'Upon receiving notice of any death resulting from accident it is the duty of the mine inspector, whose duties are performed by the Commissioner of Labor and Printing, to go at once upon receiving notice to the mine in which the accident occurred and make out an official report fully setting forth the condition of the mine where the death occurred and the cause which led to the same.

I made a personal investigation of the mines and especially that part of the same where Tolley met his death, and it was a new experience for me I assure you. I also conducted a searching inquiry into the causes of the accident and have with me the sworn statements of witnesses, the county coroner, the mine physician, mine superintendent and others.

Briefly, the facts in the case are these: They will be of interest as relating to the first serious mining accident in North Carolina during a number of years. There were four drill runners in the heading working two drills on the afternoon of the explosion: Arthur King and H.S. Holley running one drill, Penn Trolley and Cain Trolley running the other: Only L.C. Trolley and Penn Trolley were in the heading when the accident occurred. The other two had just left, one to bring water, the other going to the blacksmith shop.

The miners are paid fourteen cents a foot for drilling holes. These men sought to take advantage of a five or six foot hole, already drilled in which, there was powder that for some reason had failed to explode when the hole was fired by the preceding shift. This powder was exploded by the detonations of the drill operated by the Tolleys. The top of L.C. Tolleys head was completely blown off by some blunt instrument. The other man was slightly injured.

While, of course, all mining operations are hazardous, I consider the Cranberry mines as being reasonably safe. The headings, or tunnels, seemed to be well braced and the company appear to be interested in protecting the miners

General R. F. Hoke, of Raleigh, was formerly president of the company, now owned by Philadelphia capitalists. The mine, situated at the terminus of the East Tennessee and Western, North Carolina Railroad, owned by the same company, has been operated for more than thirty years, but much more extensively, of late. Its output a peculiar, high-grade ore is immense, an average of about three hundred men being constantly employed. The company also owns and operates a smelting plant in Johnson City, Tenn. To reach the Cranberry mines by rail it was necessary for me to go via Johnson City, Tennessee.'

Mr. Shipman was asked to describe his experience far underground, in the very bowels of the earth, making a personal inspection of the place where poor Tolley met his fate. The genial Commissioner of Labor laughed and said he couldn't do it.

'But I sure am glad I donned the overalls and colored shirt they gave me at the mouth of the mine before descending, into that black hole. I saved a suit of clothes by doing so, for when I returned I was a dark and mysterious looking specimen of humanity. The entrance into a number of the tunnels is very steep. In fact its almost like shooting the chutes, if you know what that is. The descent is long and precepitious, and the spot of light above your head gradually becomes smaller and smaller until you enter one of the headings, or tunnels, when it disappears entirely and you are in the densest gloom. The miners light their lamps. They burn a peculiar, non-explosive oil, giving forth to the unaccustomed, a strange and uncomfortable odor There are twenty-one headings or tunnels, in the mine, and to traverse any one of them is much the same as going through a railroad tunnel without an end. The further you get into these headings the more oppressive becomes the air, the more offensive the odor from the miner's oil and the more welcome your recollections of the blue skies and sunshine far above you.

The weirdly wavering flames of the miners' lamps flicker and dance, revealing dimly surroundings grotesque and unreal. The rough walls of the tunnel draw nearer and nearer, become more and more threatening Nature, angry at man's robbery of her treasure house, has already exacted heavy toll and now would entomb victims in a living grave. You feel yourself shrinking and diminishing in a stature and importance until an exceedingly small hole would suffice for you to crawl, through if but that hole led to the blessed sunlight above.

Finally we came to the spot where Tolley met death far from where death cometh to most men, and fortunately for the poor fellow it came quickly. To die up yonder is enough. To die down there makes one shrink with horror. The end came quickly and mercifully to Tolley, who, if he had made a mistake in drilling into that unexploded charge of powder, paid for it dearly.'

Mr. Shipman's report of the accident will be filed in his office as a matter of record and for future reference. As mine inspector, it is his duty to make a record of all examinations of mines, conditions in which found, extent to which the laws relating to mines and mining are observed or violated, progress made in the improvements and security of life and health, number of accidents, injuries or deaths in or about the mines, together with all such other facts and information of public interest concerning the condition of mines, development and progress of mining in the State as he may think useful and proper."

3 August 1911. The French Broad Hustler (Hendersonville, North Carolina).

"Another Accident Reported in the Cranberry Mines. Raleigh, July 31. – Commissioner of Labor and Printing, M.L. Shipman has received notice of another accident in, the Cranberry mines in Mitchell county, however not a fatal one. It seems, that a boy named Ralph Young, aged 16 years, had his foot crushed by being run over by a dump cart July 26 in the mines of the Cranberry Furnace company. He will be disabled for a month. Shipman recently made, an inspection, of the mine following a fatal accident to one of the miners."

17 August 1911. Henderson Gold Leaf.

"…I was glad of an opportunity to spend awhile at Cranberry – the famed iron mines of which I had read and heard much. The place presented a busy appearance though I did not have time to inspect the mines and see the work going on in that mountain of ore – one of the richest 'finds' of the kind in this country. There were hundreds of cars, loaded and empty, standing on

the tracks and being shifted from one place to another all belonging to the East Tennessee & Western North Carolina Railway (the ore is carried to Johnson City for smelting.)…"

8 September 1911. The Durham Recorder.

"Injured at Cranberry Iron Mines. Raleigh. – Official report came today from the Cranberry Iron mines to the state department of labor and printing giving the particulars of an accident in which Nat Young, a 'knuckle man,' was badly bruised, but not fatally injured. He was at the top of one of the inclines on which the ore cars operate when a car struck him. He had a narrow escape from death. However, no bones were broken and no internal injuries."

16 October 1911. Industrial World.

"Rumored Steel Project. The Cranberry Furnace Company, operating a blast furnace at Johnson City, Tenn., has purchased a considerable area adjoining its blast furnace plant, and is said to have in contemplation the building of open hearth furnaces. F.P. Howe, Philadelphia, is president; manager, J.A. Koss, Johnson City, Tenn."[181]

1911 and 1912. The Mining Industry in North Carolina during 1911 and 1912, by Joseph Hyde Pratt

"Production. In 1911 and 1912 the production of iron ore for North Carolina was obtained entirely from the Cranberry Mine of Avery County. In 1911 this amounted to 84,782 long tons, valued at $148,369; in 1912, to 68,322 long tons, valued at $186,264.

There is given in the table below the production and value of iron ore for North Carolina from 1900 to 1912, inclusive:

Production of Iron Ore in North Carolina, 1900 – 1912, Inclusive.

Year.	Amount Long Tons.	Value.
1900	21,000	$42,00
1901	2,578	4,997
1902	34,336	52,771
1903	82,851	78,540
1904	64,347	79,846
1905	56,282	70,352
1906	56,057	75,638
1907	75,638	113,488
1908	48,522	76,877
1909	61,150	107,013
1910	65,278	114,237
1911	84,782	148,369
1912	68,322	186,264

The name of the company is the Cranberry Furnace Company, Johnson City, Tenn."[182]

14 November 1912. Watauga Democrat.

"As a result of falling stone in the Cranberry Iron Mines on last Friday, Munroe Grimes, a colored man reared in Boone, was very seriously hurt."

1913. "Cranberry, North Carolina," by John R. Waite.

"Cranberry Iron & Coal purchased Ritter's Linville River Railway in 1913. Almost immediately, management began upgrading the lumber road to ET&WNC standards. Drop bottom gondolas loaded with waste rock from the mines was soon filling in the many trestles between Cranberry and Pineola."[183]

30 June 1915. Poors Manual of Industrials.

"Cranberry Iron and Coal Co.—Incorporated February 23, 1873, in North Carolina. Is engaged in business of mining ore. Properties located at Cranberry, N.C Annual capacity, about 70,000 gross tons. Mine is leased to The Cranberry Furnace Co. Controls, through ownership of their entire capital stocks, The East Tennessee and Western North Carolina RR. Co., Linville River Ry. Co. (for statements of which see Poor's Manual of Railroads) and The Cranberry Furnace Co.

Income Account, year ended June 30, 1915.—Gross revenues, $81,806. Expenses, interest and taxes, $11,803. Net income, $70,003. Dividends (1 p.c), $9,347. Surplus "for year, $60,656.

Profit and Loss Account, year ended June 30, 1915.—Credits: Surplus, June 30,1914, $109,812; surplus for year ended June 30, 1915, $60,656—total, $170,468. Miscellaneous debits, $1,376. Surplus as per balance sheet, $169,093.

General Balance Sheet, June 30, 1915.—Capital stock outstanding, $934,700; accrued liabilities, $1,895; current liabilities, $1,738; profit and loss, $169,093—total, $1,107,426. Contra: Property account, $302,474; securities of affiliated companies owned, $750,800: accrued income not due, $1,891; other investments, $8,719; deferred assets, $20,426; working assets, $23,115—total, $1,107,426.

Capital Stock.—Authorized, $5,000,000. Outstanding, July 1, 1915, $934,700. Shares, $100. Transfer agent, J.E. Vance, Johnson City, Tenn. Annual meeting, first Thursday after second Wednesday in September, at Cranberry, N.C. Books do not close. Not listed. No bonds.

Dividends.—Dividends are paid May 1 and Nov. 1. In 1912 2 p.c. was paid; 1913, 4 p.c.; 1914, 3 p.c; 1915, 1 p.c; 1916 (to June 30), 3 p.c.

Directors.—Frank Firmstone, Easton, Pa.; H.M. Howe, Henry Lewis, Frank P. Howe, Edgar P. Earle, Ario Pardee, Philadelphia, Pa.; one vacancy.

Officers.—F.P. Howe, Pres.; Ario Pardee, Vice-Pres.; John S. Wise, Sec. and Treas., Cranberry, N.C. Office, Cranberry, N.C."[184]

Figure 59. "A couple of surveyors pose with the engineer of Cranberry Iron & Coal Company #1, an 0-4-0 Porter locomotive that moves ore buggies around the Cranberry mine, c. 1915. Ed bond Collection."[185]

1916. "Cranberry, North Carolina," by John R. Waite.

"The railroad facilities were just south of the mine. They included an engine house, a turntable, a coaling platform, and a water tank. Sometime prior to 1916, the turntable was removed and a wye was constructed north of the mines. Later, the water tank was moved to the wye."[186]

February 1916. "Report on the Forest Tract Owned by the Cranberry Iron and Coal Company, Cranberry, N.C. February, 1916.

This property, consisting of some 3,700 acres, lies on the waters of Elk Creek, which flows north into Watauga River just above Butler, Tennessee. The East Tennessee and Western North Carolina Railroad, from Johnson City to Cranberry, enters the property; and the Linville River Railway, from Cranberry to Montezuma, passes through the property for two or three miles. Years ago an iron furnace was operated on the property, and about half of the tract has been cut over for the purpose of making charcoal to, supply the furnace. The cutting of the timber for this purpose ceased some twenty years ago.

An effort has been made, with considerable success, to keep fires out of the second growth forests which have resulted from the cutting. In consequence, the woods are in good condition and the young growth has in many cases made exceptional growth. Fine young stands of chestnut, poplar and other species are found, in some places almost pure but in most places

mixed, and varying in age from 20 years up to 80 or 90 years. This is perhaps the best example of even-aged, second-growth, hardwood forest to be found anywhere in North Carolina.

Some cutting has been done from time to time, chiefly for the use of the estate. The owner now wishes to thin out the chestnut stands, doing a certain amount each year, with the two-fold object of getting some return from the property and of improving the remaining stand. This latter object is the first consideration in cutting.

The chestnut is largely coppice growth, a number of trees growing out from each stump. Many of the smaller poles are dying because shaded by the larger ones. It is recommended that all dead, crooked, fire-scarred, or otherwise damaged trees, shall be taken out and used for telephone poles or chestnut extract cordwood, leaving only one thrifty tree to the stump. In some cases all the poles on the stump may be cut, provided there are satisfactory trees near-by which will not be left too much separated. Thinning should be done in such a way that the trees left will close up the open spaces with their branches in about five years. A heavier thinning than this would cause the trees to form side branches and stop the growth in height, both results to be avoided. Care should be taken to select for leaving those trees which will largely increase in value. It will not pay to take out trees which will double in value in the next ten years. Small, thrifty poles, which now would make small telephone poles, will, under the proposed system of thinning, become large poles in ten years' time, and will be worth at least twice as much then as they are now.

Sell for poles now only those that are in the way of other thrifty poles; or those that have a crook 20-25 feet up, which would prevent their ever making high-priced poles. Older stands, ranging from 40 years and up, may be made to furnish some large-sized poles by cutting for openings and groups. Openings made by the removal of several large trees will let in sufficient light to start and sprout reproduction from the stumps and seedling reproduction from the surrounding trees. The remaining groups surrounding the openings may consist of smaller trees thinned around as in the younger stands, or partly composed of other species, such as poplar, linn, or red oak.

Unless the land is to be cleared chestnut should never be cut in the summer or fall. By summer cutting the stumps are so weakened that the sprouts growing from the stumps will be weak and the resulting crop of sprouts inadequate to form a thrifty second crop of poles. Cutting should not be done later than May, certainly not later than June; it may begin in the fall as soon as the leaves begin to turn color. Poplar trees can be left closer than chestnuts, as they grow in height more readily. Thinning poplar too heavily will result in a shorter tree and very likely in having more limby and knotty boles. Where mixed with chestnut, poplar should be favored at the expense of the chestnut, as it will in all probability be more valuable. Black birch is being sold to a man who will cut it and use the whole tree for distillation. This taking out of the black birch will be of advantage to the forest, as it will give more room to the poplar which usually grows with it. It would probably pay to have it removed even though no cash returns were realized. The distillers should be cautioned about fire and watched pretty closely to see that they are careful.

J.S. Holmes,
State Forester.

Approved: Joseph Hyde Pratt,
State Geologist."[187]

1916. International Mining Manual (Twenty-Fourth Annual), 1916…

"Cranberry Furnace Co… Frank P. Howe, Johnson City, Tennessee, General Manager. S.H. Odom, Superintendent.

Cranberry Mine. Magnetite. Slope. Steam Power and Compressor.

200-ton Concentrating Mill. 200 Men."[188]

25 January 1917. Watauga Democrat.

"An exchange says that ore from the Cranberry mines in Avery county, is being inspected, steel and ore man, and analysis will be made to ascertain if it is not what the government wants for armor plate. According to reports this expert was at Cranberry last week and soon a report of his findings will be given out."

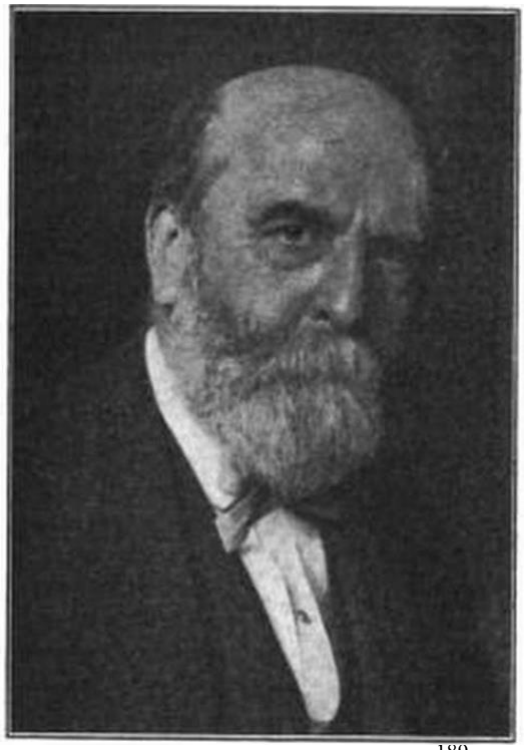


Figure 60. "Frank Firmstone"[189]

27 June 1917. Transactions of the American Society of Civil Engineers.

"Died June 27th, 1917. Frank Firmstone, the son of William and Mary Elizabeth Firmstone, was born on August 29th, 1846, at the Glendon Iron Works, near Easton, Pa., which his father had built in 1842. He received his early education at the Old Philips School in Easton. Later, he was sent to the Saunders Military Institute, in Philadelphia, Pa., where he was prepared for the Polytechnic College of Pennsylvania, and was graduated from that college as a Mining Engineer in June, 1865.

In November, 1865, Mr. Firmstone was employed as Levelman on surveys for the Wilmington and Brandywine Railroad, which position he held until March, 1866.

In January, 1867, he became associated with his father, as Assistant Superintendent, in the management of the Glendon Iron Works, remaining in this position until May, 1877, when his father died. Mr. Firmstone then took full charge of the Iron Works as General Manager, and retained this position until 1887, when he retired from active business. As Assistant Superintendent and as General Manager he made the designs and superintended the construction of all new work at the plant, including blast furnaces, etc., as well as repairs and alterations.

Subsequent to 1887, he became associated with the Cranberry Iron and Coal Company, serving for a number of years as its President and as a Director on the Boards of all its subsidiary companies until his death, which occurred at his home in Glendon, Pa., on June 27th, 1917.

He is survived by his brother, Mr. Harry Firmstone, of Longdale, Va.

Among other societies and clubs Mr. Firmstone was a member of the American Institute of Mining Engineers, and as such had contributed to its publications many interesting and valuable papers on blast furnace practice and on matters pertaining to the manufacture of pig iron, on which subject he was considered quite an authority.

He was also a member of the American Society for Testing Materials, American Forestry Association, Engineers' Club of New York City, Automobile Club of Philadelphia, Pa., Country Club of Northampton County, Pomfret Club of Easton, Pa., Northampton County Historical and Genealogical Society, and Trinity Protestant (Episcopal) Church, of Easton, Pa.

Mr. Firmstone was elected a Member of the American Society of Civil Engineers on August 7th, 1878."[190]

30 June 1917. Poor's Manual of Industrials; Manufacturing, Mining and Miscellaneous Companies.

"Cranberry Iron and Coal Co.—Incorporated February 23, 1873, in North Carolina. Is engaged in business of mining ore. Properties located at Cranberry, N.C. Annual capacity, about 70,000 gross tons. Mine is leased to The Cranberry Furnace Co. Controls, through ownership of their entire capital stocks, The East Tennessee and Western North Carolina RR. Co., Linville River Ry. Co. (for statements of which see Poor's Manual of Railroads) and The Cranberry Furnace Co.

Income Account, year ended June 30, 1917.—Gross revenues, (including dividend received), $196,499. Expenses, interest and taxes, $21,563. Net income, $174,037. Dividends (6 p.c.), $56,082. Surplus for year, $118,855.

Comparative General Balance Sheet, June 30.

Assets:	1917	1916	Liabilities:	1917	1916
Physical property	$312,102	$304,418	Capital stock	$934,700	$934,700
Securities of affiliated companies owned	890,800	750,800	Working liabilities	2,017	2,913
Other investments	7,779	7,703	Accrued liabilities not due	6,383	1,886
Working assets	84,223	28,680			
Accrued income not due	1,684	1,915	Deferred credit items	82,250	
Deferred debit items	67,704	66,545	Profit and loss	338,940	220,563
Totals	$1,364,291	$1,160,063		$1,364,291	$1,160,063

Capital Stock.—Authorized, $5,000,000. Outstanding, June 20, 1917, $934,700. Shares, $100. Transfer agent, J. E. Vance, Johnson City, Tenn. Annual meeting, first Thursday after second Wednesday in September, at Cranberry, N. C. Books do not close. Not listed. No bonds.

Dividends.—Dividends are paid May 10 and Nov. 10. In 1912 2 p.c. was paid; 1913 4 p.c.; 1914, 3 p.c.; 1915, 1 p.c.; 1916 and 1917, 6 p.c. each, including 2 p.c. extra in both years. Books close ten days before dividend payments.

Directors.—Henry Lewis, Frank P. Howe Edgar P. Earl, Ario Pardee, Philadelphia, Pa; D.N. Mackie, Cranberry, N.C. (two vacancies).

Officers. – F.P. Howe, Pres.; Ario Pardee, Vice-Press.; John S. Wise, Sec. and Treas., Cranberry, N.C. Office, Cranberry, N.C."[191]

1917 – 1921. "General Features of the Magnetite Ores of Western North Carolina and Eastern Tennessee," by W.S. Bayley.

"Since 1884 the [Cranberry] mine has produced about 1,250,000 tons of merchantable ore, and during the four years 1917 to 1920 it produced about 50,000 tons annually. In 1921 the mine was temporarily closed.

The ore as it comes from the mine is a nontitaniferous magnetite, which may be almost pure or intimately mixed with hornblende or with hornblende and other components of the gangue. Recently it has been shipped to the furnace as mined. Formerly the purer ore was separated from the leaner product by hand picking, and the leaner ore was concentrated by crushing, screening, and treatment with electro magnets. The result of this method of concentration was not regarded as satisfactory in view of its cost, and therefore it was abandoned in 1920…"[192]

20 January 1918. Richmond Times-Dispatch.

"Iron Mining Boom in Carolina. A special telegram from Raleigh, N.C., to the Manufacturers' Record says:

The war has vastly increased the output of the noted Cranberry iron mine in Mitchell County, and is causing the opening of a number of other iron properties in the State…"

11 August 1918. Richmond Times-Dispatch.

"Carolina Iron Mining – Much Ore being Dug from Mountain Sides in Western Part of North State. Concerning iron mines and the working of the same in North Carolina. Colonel Fred A. Olds writes the Manufacturers' Record as follows…

By far the most important mining in all North Carolina is that at the Cranberry mine, in Avery County. The annual production of this mine approximates 70,000 tons, and it all goes to the company's smelter at Johnson City, Tenn., over the East Tennessee and Western North Carolina Railway, which is owned by the Cranberry company. This mine has produced to date about 1,400,000 tons of ore, which ranks among the best in the United States. It is magnetite…"

1918. Moody's Manual of Railroads and Corporation Securities.

"Cranberry Iron & Coal Co.—Inc. Feb 28, 1873, in N.C. Owners of the Cranberry Mine (low phosphorus iron ore mine) and of the entire capital stock of the Cranberry Furnace Co., East Tennessee & Western North Carolina RR Co. and the Linville River Ry Co. (see Railroad Volume). Mine located at Cranberry, N.C.; blast furnace at Johnson City, Tenn. Annual capacity, about 75,000 gross tons.

Capital Stock—Authorized, $5,000,000; outstanding, $934,700; par, $100. Stock transferred at company's office. Dividends have been paid in recent years, as follows: Nov 1, 1912, May 1, and Nov 1, 1913, and May 1, 1914, 2% each; Nov 10, 1914 and Nov 1, 1915, 1% each; May 15 and Nov 10, 1916 and May 21 and Nov 10, 1917, 2% and 1% extra each; May 10 and Nov 10, 1918, 2% each.

Income Account, Years Ended June 30.

	Gross Revenues.	Exp. Incl. Int. & Taxes.	Net Income.	Dividends.	Surplus for Year.
1914	$88,043	$13,067	$74,976	$37,388	$37,588
1915	81,806	11,803	70,003	9,347	60,656
1916	101,495	12,636	88,859	37,388	51,471
1917	196,499	21,563	174,936	56,082	118,854
1918	197,391	14,830	182,561	46,735	135,826

General Balance Sheet, June 30.

Assets:	1918	1917	Liabilities:	1918	1917
Physical property	$403,465	$312,102	Capital stock	$934,700	$934,700
Securities of affiliated companies owned	1,037,800	890,800	Non-negotiable debt to affiliated companies	27,00	
Other investments	7,848	7,779	Current liabilities	2,341	2,018
Current assets	26,938	84,223	Accrued liabilities		6,384
Accrued income not due		1,684	Deferred credit items	52,840	82,250
Deferred debit items	706	67,704	Profit and loss	459,876	338,940
Totals	$1,476,757	$1,364,292		$1,476,757	$1,364,292

Officers: Frank P. Howe, Pres.; Ario Pardee, V-P; A.H. Fisher, Sec.; J.E. Vance, Treas., Cranberry, N.C. Directors: Henry Lewis, Edgar P. Earle, Ario Pardee, Frank P. Howe, Philadelphia, Pa.; D.W. Mackie, Cranberry, N.C.; J.H. Epps, Jonesboro, Tenn.; Geo. W. Hardin, Johnson City, Tenn.

Annual meeting, first Thursday after second Wednesday in Sept.

General office, Cranberry, N.C."[193]

1919 – 1920s. "Cranberry, North Carolina," by John R. Waite.

"After World War I, the iron business began to fall off. The mines were shut down for extended periods of time during the 1920s. Each time they reopened fewer workers were required. The population of Cranberry quickly declined as miners and their families moved away."[194]

May 1919. Highway Engineer and Contractor, A Journal of State and City Engineering and Construction Problems.

"Highway Work in North Carolina. Watauga county, N.C., which up to a year ago was roadless both as to railroads and highways, now has both. This county has two steam shovels at work and on the last day of the year it is planned that one of these, climbing to the crest of the Blue Ridge, shall shake hands with another shovel now working its way up the south face of that high range through the county of Wilkes. The latter county is building in handsome style its half of this highway across the state.

Avery county, which has built many miles of excellent highways, is surfacing its roads with crushed granite, the refuse of the Cranberry iron mine and is able to buy the material at 65 cts. a cu. yd. Three years ago Avery was roadless.

Ashe county is spending $600.000 on its highways.

Watauga county highway bond issue is for $300,000. The mileage in the hands of a private company, consisting of 10 miles of toll road, has been bought. This road was built in 1893 and connects Boone and Blowing Rock, the latter being a great summer and health resort on the crest of the Blue Ridge, 4484 ft. high…

Throughout the mountain region there is considerable discussion regarding taking over large areas as additions to forest reserves and thus securing Government built or aided highways, safe and with light grade. This sentiment was extremely strong in the Grandfather region, where the Government has been presented with 3600 acres, including all the top of that great mountain: also in the Roan mountain region and the border line of Tennessee and North Carolina…"[195]

1919 – 1924. "Operation of Cranberry Iron Mine

In June of 1986, while exploring the Cranberry area searching for information on the ET&WNC, I [John R. Waite] met 'Preacher' Brown. I have interviewed him several times since then and he has proven to be a valuable source of information on the operations of the Cranberry iron mine.

'Preacher' Brown was born in 'Tucker Holler', about two miles above Cranberry in 1906. His father had been disabled in a mine explosion and the thirteen children in the family were forced to work to help support the family. He went to work at the mine in 1919 as a 'mule boy'. He worked at the mine until 1924, when he went to work in the lumber yards at Cranberry.

The Cranberry mine operation can be divided into four basic areas; the main mine, the surface diggings, the yard complex, and several small mines in the surrounding area. I will a try to give a brief overview of these operations, however it must be remembered that these are the reminescences of an octogenarian as interpreted by someone with only rudimentary knowledge of iron mining.

The main mine was a tunnel over a mile into the mountain. It started out level but then had a gentle upward slope. At the end of the main tunnel there were incline shafts to secondary

tunnels. These secondary tunnels would follow the ore veins. These secondary tunnels were where the actual mining was going on and were known as the 'head' of the mine.

All of the ore was moved in one ton ore cars. These cars were approximately four feet long, three feet wide, and two and one-half feet tall. They rolled on small spoked wheels. Link and pin couplers were used. Empties were pushed into the mine by an 0-4-0 saddle tank engine (Tweetsie Country p. 52). This engine was called the 'Dinky'. Because of the height of the main tunnel, this engine could only push the cars about three-fourths of the way into the mine. From this point, called the 'Buzzards Roost', on mules were used. Each mule would pull two cars. The mules were stabled in a large barn near the company store and were brought up to the mine each morning by the 'mule boys'. There were generally five mules working in the mine, but the company owned a great many more. After the mule had pulled the ore cars to the end of the main tunnel the cars would be pulled up the incline shafts by hoist engines.

At the head of the mine, 'drillers', using steam powered drills, would drill holes for the dynamite. After the dynamite broke up the rock, the ore was loaded into the ore cars by 'muckers'. The cars were then lowered by the hoist to the main tunnel where they were put on sidings by the 'car boys'. When about thirty-five cars had been assembled they would be gravity rolled down the level section of the main tunnel. This was known as tunnel level. The car boys would use small stones under the wheels of the ore cars to keep them in place on the sidings. Once the cars were moving down the grade, braking was done by throwing four feet long, steel rods called 'sprags' through the spokes of the wheels of some of the cars. As the cars rolled down through the dark tunnel sparks would be shooting from the locked wheels creating quite a display. From 'tunnel level', the 'Dinky' would push the loaded ore cars out of the mine to the yard area.

Deep in the mine, near the 'Buzzard's Roost' were the drill sharpening shops. 'Driller's helpers' were kept busy shuttling materials and equipment back and forth from the shop area to the head of the mine. Drillers were paid on a per foot basis, and muckers were paid per car load. They received metal 'checks' to attach to each car they loaded. These checks would be collected at the tipple and determined the muckers pay. The mule boys and car boys were paid on a per diem basis. 'Preacher' Brown started at 1.75 per day and had worked up to $1.25 par day when he quit.

Of course they worked six days per week. One of the unique benefits supplied by the company was a large indoor swimming pool, directly across the valley from the mine. This pool was used by the miners to clean up and by the miners children for recreation. Supervision was in the hands of the 'Drill Boss', the 'Mucking Boss', the 'Walkin Boss', and of course the Superintendent of the mine.

The yard area included the crusher and tipple, the boiler house, compressor house, 'check out' building, hoist house, and several materials buildings, as well as the railroad roundhouse and tracks. The ore cars would be uncoupled in groups of three and hoisted up onto the tipple. One at a time they would be placed in a rotary dump and emptied into the crusher. After they were emptied, they would be pushed on down the tipple track. At the end of the tipple there were two large blocks, when the car hit the blocks a switch was thrown and the car bounced off the blocks and down the return track to a siding.

Steam was generated in the large boiler house with five boilers. It was then fed to the mine operations through a system of steam pipes.

Surface mining for a crumbly ore known as 'rattlesnake ore', was done in t[w]o locations Middle Hill, just above the mine entrance and Top Hill, on up the mountain. Ore seems to have

been dropped from Top Hill down into the mine through a series of chutes and hoppers, for loading into the ore cars. Ore from the Middle Hill was dumped down chutes, directly into 'Tweetsie' hopper cars. Two of these chutes can be seen in Tweetsie Country, on page 13. The largest of the two is loading a hopper car directly behind the tipple in the photo. A worker would be in the car breaking up the ore with a sledge hammer.

The fourth, and least important part of the mine operation was a few small mines in the surrounding countryside, owned by Cranberry Iron. These mines sent their ore into Cranberry by mule-drawn wagons. These operations seem to have ended fairly early, probably lasting no longer than the end of World War I…"[196]

30 December 1920. The News Scimitar (Memphis, Tennessee).

"Bristol, Tenn. The Cranberry furnace company, near Johnson City, and the mines at Cranberry will close down within the next day or so for an indefinite period, according to information received here. The cause of the shutdown is understood to be due to the falling price of ore, which makes the cost of production greater than the price obtained."

1920. American Mining Manual.
"Cranberry Furnace Co., Cranberry.
Frank P. Howe, Johnson City, Tennessee, General Manager.
S.H. Odom, Superintendent.
Cranberry Mine. Magnetite. Slope. Steam Power and Compressor.
200-ton Concentrating Mill. 200 Men…

Cranberry Furnace Co., Johnson City…
Incorporated, New Jersey, 1902. Stock, $100,000. Shares, $100.00.
Frank P. Howe, Johnson City, Tenn., President and Manager.
Hammond Prosser, Johnson City, Tenn., Sec. and Purchasing Dept
S.H. Odom, Cranberry, North Carolina, Mine Superintendent.
Cranberry Magnetite Iron Ore Mine, Cranberry, North Carolina.
Slope. Steam and Compressor. 200-ton Crusher. S. Locomotive.
Cranberry Furnace, Johnson City, Tennessee.
1 Blast Furnace. 4 Whitwell 4-Pass Stoves. 3 Steam Blowers. 1000 HP. Steam Power Plant. Product: Low Phosphorus Pig Iron."[197]

11 August 1921. Watauga Democrat.

"Prospects for Watauga Bright… Good roads are coming, Editor Harris of the Charlotte Observer tells his friends about Blowing Rock, when he comes up to visit his family, that a hard surfaced road from Charlotte to Boone is not far away. Governor Morrison it is reported, favors this. Chief Engineer Upham who was here last week, endorses the project. Boone is also rejoicing that it is on the Boone Trail Highway which will connect us with Winston Salem on the east and Bristol on the west. Crushed stone will be purchased at the Cranberry mines and shipped here to put on this road for several miles each way from Boone. We are looking to see the links built to put us in touch with Asheville via Valle Crucis, Banner Elk, and Spruce Pine.

When these roads are finished Boone will be the most accessible town in this section…"

13 October 1921. Watauga Democrat.

"The work on the water bound macadam on the Boone Trail Highway is progressing nicely. The work would progress more rapidly if the crushed stone, being shipped by rail from the Cranberry mines, could be delivered faster. The work now extends to the rail-road bridge one mile east of Boone."

1921. Moody's Manual of Railroads and Corporation Securities.

"Cranberry Iron & Coal Co. – Inc. Feb 28, 1873, in N.C. Owners of the Cranberry Mine (low phosphorus iron ore mine) and of the entire capital stock of the Cranberry Furnace Co., East Tennessee & Western North Carolina RR Co., and the Linville River, Ry Co., (see Railroad Volume). Mine located at Cranberry, N.C., blast furnace at Johnson City, Tenn. Annual capacity, about 75,000 gross tons.

Capital Stock. – Authorized, $5,000,000; outstanding, $934,700; par, $100. Stock transferred at company's office.

Dividends. – Dividends have been paid in recent years, as follows: Nov 1, 1912; May 1, and Nov 1, 1913, and May 1, 1914, 2% each; Nov 10, 1914, and Nov 1 1915, 1% each; May 15, 1916 to and including May 10, 1920, 2% semi-annually, M&N 10. In addition extra dividends of 1% each were paid May 15 and Nov 10, 1916, and May 31 and Nov 10, 1917.

Income Account, Years Ended June 30.

	Gross Revenues.	Exp. Incl. Int. & Taxes	Net Income.	Dividends	Surplus for Year
1914	$88,043	$13,067	$74,976	$37,388	$37,588
1915	81,806	11,803	70,003	9,347	60,653
1916	101,495	12,636	88,859	37,388	51,471
1917	196,499	21,563	174,936	56,082	118,854
1918	197,391	22,744	174,648	46,735	127,913
1919	210,785	20,764	190,021	37,388	152,637
1920	106,693	*64,034	42,659	37,388	5,271

* Includes $30,725 depreciation for previous years.

General Balance Sheet, June 30.

Assets –	1920.	1919.	Liabilities –	1920.	1919.
Physical property	$408,448	$408,227	Capital stock	$934,700	$934,700
Securities of affiliated companies owned	1,187,800	1,140,800	Current liabilities	2,110	2,543
Other investments	10,075	8,420	Deferred credit items	91,269	52,713
Currents assets	32,492	37,412			
Deferred debit items	987	1,544	Profit and loss	611,714	606,443
Total	$1,639,793	$1,596,403	Total	$1,639,793	$1,596,403

Officers: Frank P. Howe, Pres.; Ario Pardee, V.P.; A.H. Fisher, Sec.; J.E. Vance, Treas., Cranberry N.C.

Directors: Henry Lewis, Edgar P. Earle, Ario Pardee, Frank P. Howe, Philadelphia, Pa.; D.W. Mackie, Cranberry, N.C.; J.H. Epps, Jonesboro, Tenn.; Geo. W. Hardin, Johnson City, Tenn.

Annual Meeting, first Thursday after second Wednesday in Sept.

General Office, Cranberry, N.C."[198]

May 1922. The Blast Furnace and Steel Plant.[199]

"Trade Notes… Freyn, Brassert & Company, Chicago, have been retained as consulting engineers by the Cranberry Furnace Company of Johnson City, Tenn."

15 June 1922. Watauga Democrat.

"A corps of workmen are now engaged in doing repair work on buildings and machinery at Cranberry, and everything is being put in shape for resuming work in the world-famous Cranberry mines, and the big smelters at Johnson City, Tenn., are being relined preparatory to handling the output as soon as the mines open, which will be in the very near future. The Company employs quite an army of men and this item will be read with delight by many who are seeking employment."

23 November 1922. Watauga Democrat.

"Cranberry Iron Mines Resume their Operations. The Cranberry Iron Coal & Coke Co that has been idle many moths resumed work Monday morning with a full crew of hands, some little work having been done last week. The closing down of this big operation was almost a tragedy to a large number of men and their families, who for a great many years have depended on it for their support. When running on full time from three to five hundred men get lucrative employment there."

1922. Moody's Analyses of Investments and Security Rating Books.

"Cranberry Iron & Coal Co.: Incorporated under the laws of North Carolina, Feb. 28, 1873. Controls the following companies through ownership of the entire capital stock, Cranberry Furnace Co., Linville River Ry. Co., and the East Tennessee and Western North Carolina R.R. Co. Company owns a low phosphorus iron ore mine, known as the Cranberry Mine, located at Cranberry, N.C., also a blast furnace at Johnson City, Tenn., having an annual capacity of 75,000 gross tons of ore.

Management: Officers: F.P. Howe, Pres.; Ario Pardee, Vice-Pres.; A.H. Fisher, Sec.; J.E. Vance, Treas., Cranberry, N.C. Directors: Henry Lewis, E.P. Earle, Ario Pardee, F.P. Howe, Philadelphia, Pa.; D.W. Mackie, Cranberry, N.C.; J.H. Epps, Jonesboro, Tenn.; Geo W. Hardin, Johnson City, Tenn. Annual Meeting: First Thursday after second Wednesday in September. Office: Cranberry, N.C.

Comparative Income Account, Years Ended June 30

	1921	1920	1919
Gross revenues	$48,279	$106,693	$210,785
Exp., int., taxes, etc.	31,876	*64,034	20,764
Net income	$16,403	$42,659	$190,021
Dividends	18,694	37,388	37,388
Surplus	(def.) $2,291	$5,271	$152, 633

*Includes $30,725 depreciation for previous years.

Comparative Balance Sheet, As of June 30

Assets:	1921	1920	1919
Physical property	$408,315	$408,315	$408,227
Securities owned	1,159,800	1,187,800	1,140,800
Other investments	47,000	10,075	8,420
Current assets	30,903	32,492	37,412
Deferred items	1,453	987	1,544
Total	$1,647,471	$1,639,793	$1,596,403
Liabilities:			
Capital stock	$934,700	$934,700	$934,700
Current liabilities	7,536	2,110	2,545
Reserves	95,812	91,269	52,715
Surplus	609,423	611,714	606,443
Total	$1,647,471	$1,639,793	$1,596,403

Capital Stock: Cranberry Iron & Coal Co., stock: Authorized $5,000,000; outstanding, $934,700; par $100. No bonded debt. Dividends paid as follows: 1912, 2%; 1913, 4%; 1914. 3%; 1915, 1%; 1916 and 1917, 6% each; 1918 to and including Nov. 10, 1920, 4% per annum; none reported thereafter through 1921. Dividends payable semi-annually M. & N. 10. Rating, Ca.

Stock transferred at company's office."[200]

1922. The American Mining Manual, 1922.
"Cranberry Furnace Co., Johnson City.
Incorporated, New Jersey. 1902. Stock, $100,000. Shares, $100.00.
Frank P. Howe, Johnson City, Tenn., President and Manager.
Hammond Prosser, Johnson City, Tenn., Sec. and Purchasing Dept
S.H. Odom, Cranberry, North Carolina, Mine Superintendent.
S.F. Boren, Johnson City, Tennessee, Furnace Superintendent.
Cranberry Magnetite Iron Ore Mine, Cranberry, North Carolina.
Slope. Steam and Compressor. 200-ton Crusher. S. Locomotive.
Cranberry Furnace, Johnson City, Tennessee.
1 Blast Furnace. (36,000 Tons) 4 Whitwell 4-Pass Stoves.
3 Steam Blowing Engines. 850 HP. Steam Plant: 12 Boilers."[201]

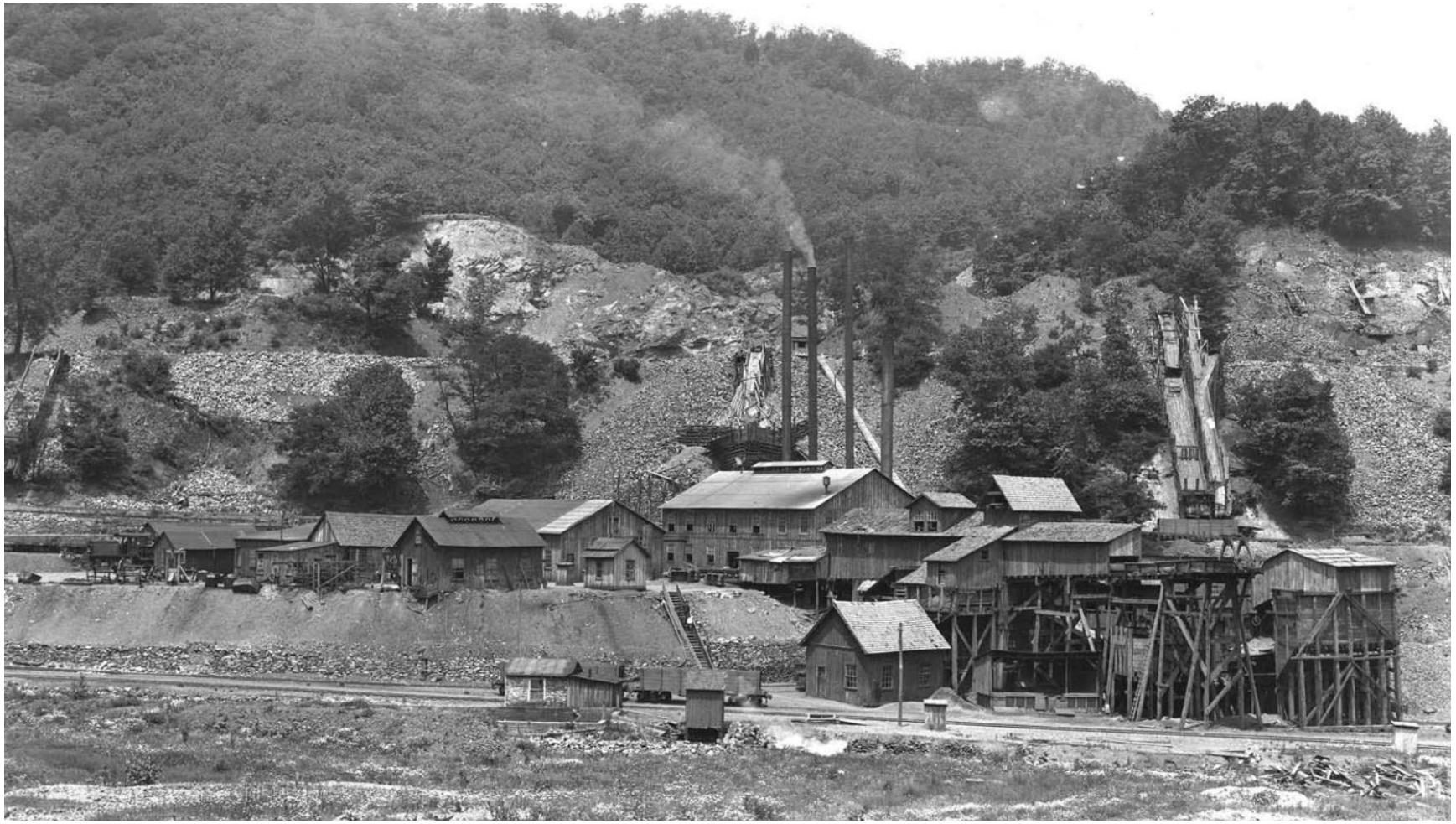


Figure 61. "The Cranberry mine in the years following World War I is a large complex for extracting substantial amounts of ore from both surface diggings and underground tunnels. This photo is of the mine in its mid-years, and it seems to be in its prime. Note the partially hidden shay on the far right. Several types of hoppers and gons can be seen around the property. James T. Dowdy Collection." Chris Ford captioned this photo: "Best portrait photo of upgraded mine operation, from around 1910".[202]

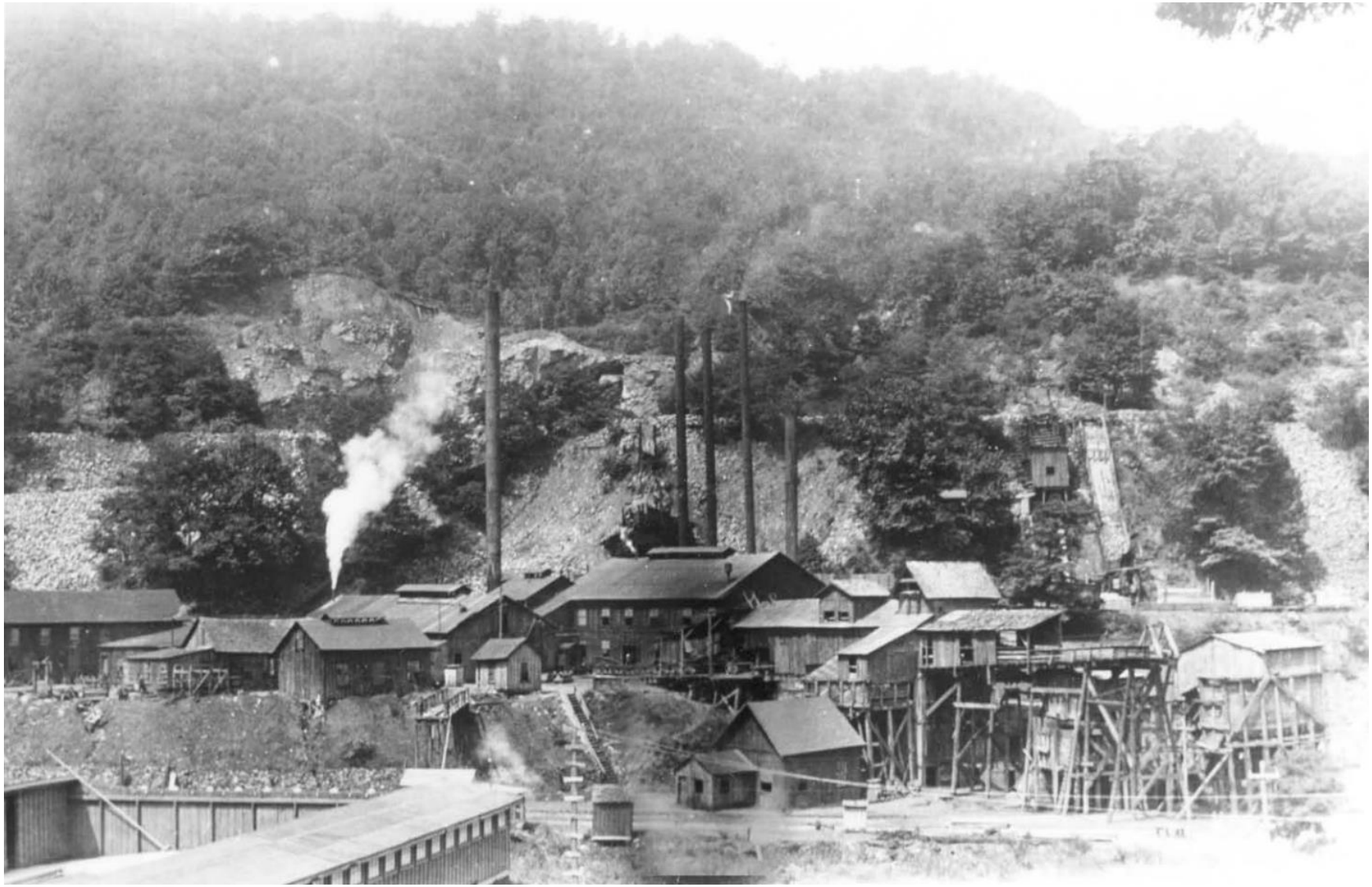


Figure 62. 1923: "The Cranberry mine complex is across the valley from the company swimming pool. The pool provides a convenient way for workers to wash off dirt and grime… James T. Dowdy Collection." Chris Ford captioned this photo: "Portrait of mine operations late in its life, with swimming pool, circa 1925".[203]

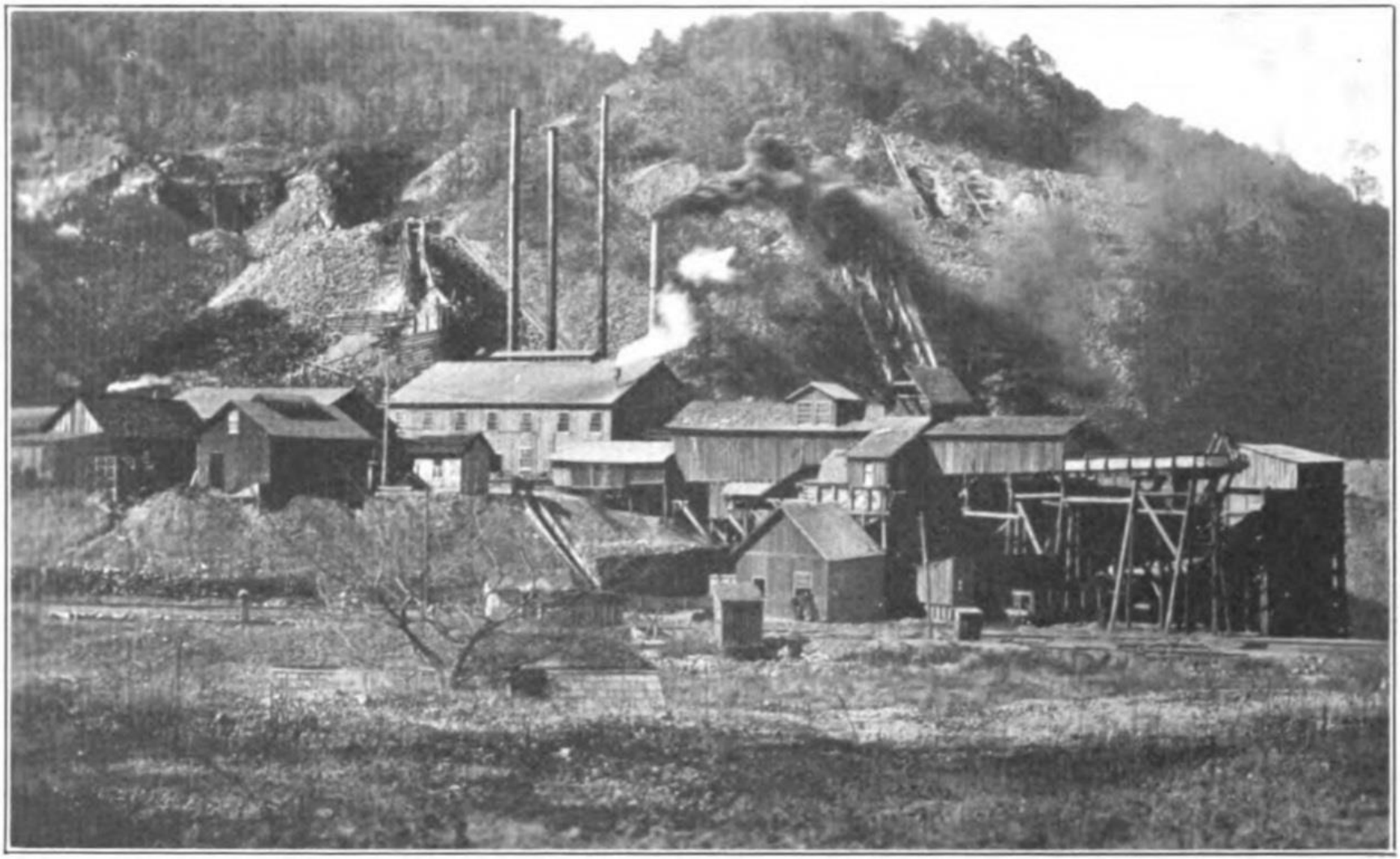


Figure 63. "View of Cranberry mine, Cranberry, Avery County, North Carolina. Looking northwest along the vein."[204]

1923. The Magnetic Iron Ores of East Tennessee and Western North Carolina, by W.S. Bayley.[205]

"Cranberry Mine
General description of mine and ore

The most notable deposit in the belt running from Vale to the Doe River is, as has been said, at the Cranberry mine, on the east slope of Cranberry Ridge. (See Plates XII and XIII) In 1876 the mine came into the possession of its present owners and in 1882 it was connected with Johnson City by rail. In 1884 a small blast furnace was built and smelting of the ore was begun. Later, in 1900, this furnace was abandoned, a larger one having been built by the Cranberry Furnace Co. at Johnson City (Plate XIV), and since May, 1902, the ore has been smelted there. The capacity of the furnace is 100 tons of pig iron daily, and the Cranberry mine furnishes most of the ore from which the iron is produced. Since 1884 the mine has produced about 1,250,000 tons of merchantable ore, during the past 4 years (1917-18-19-20) at the rate of about 60,000 tons annually. The mine was closed temporarily in January, 1921, but was again working in 1923."

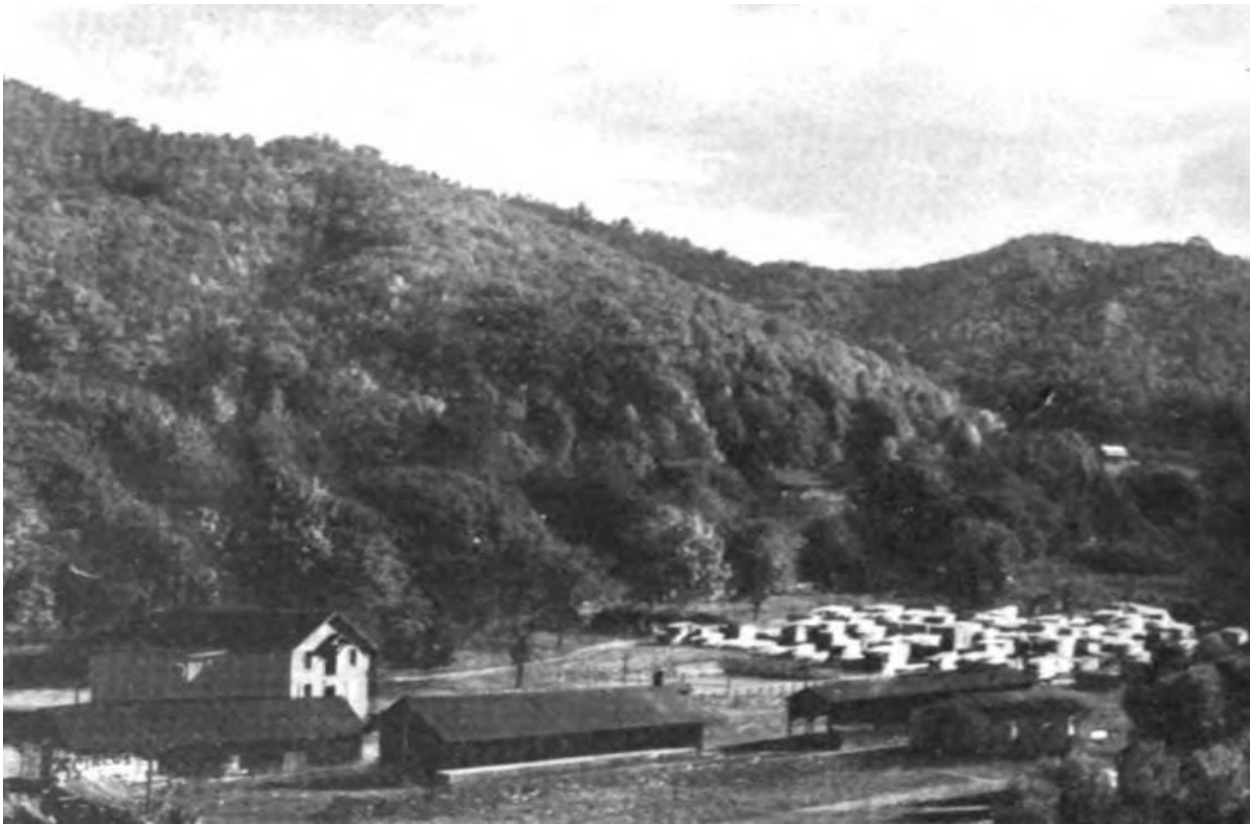


Figure 64. "View toward 'Smoky Mountain' looking east from Cranberry, Avery County, North Carolina. The Cranberry vein runs across the mountain to the left of the high peak."

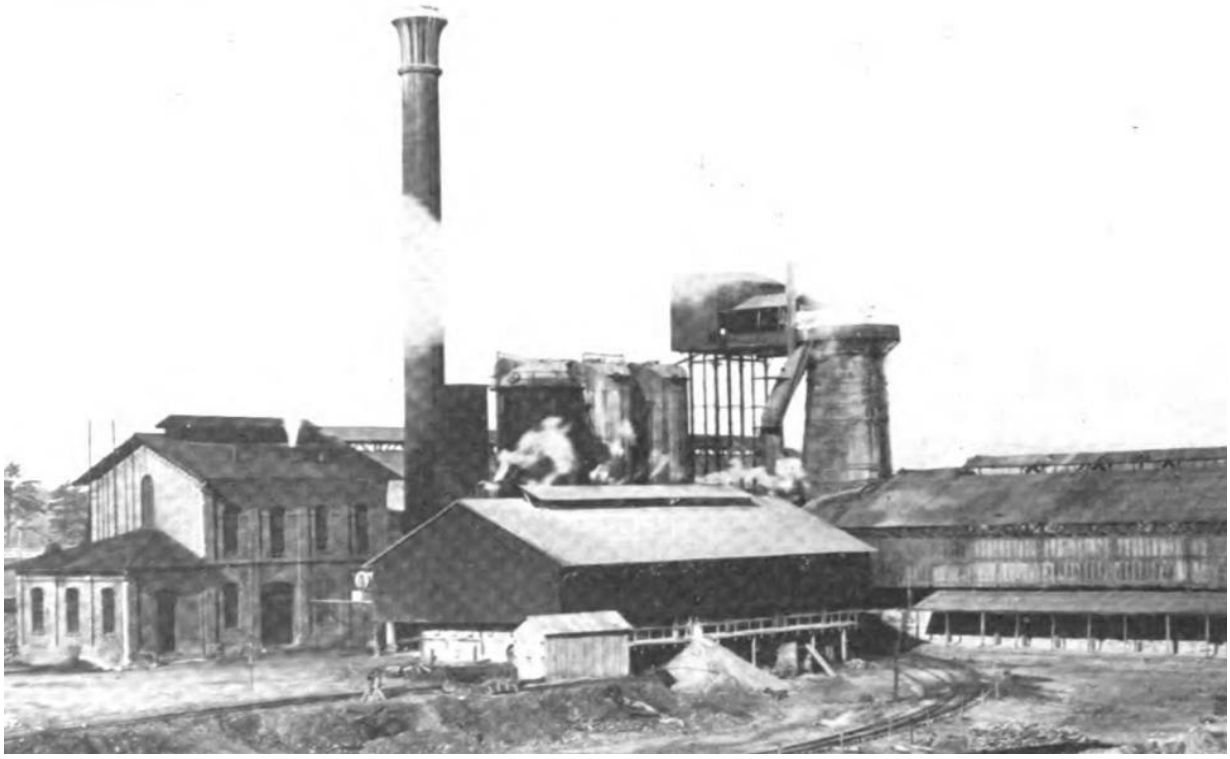


Figure 65. "Cranberry Furnace, Johnson City, Tenn."

"The ore as it comes from the mine is a non-titaniferous magnetite, which may be almost pure, or which may be intimately mixed with hornblende or with hornblende and other components of the gangue to be described later. Formerly the pure ore was separated from the leaner product by hand-picking, and the leaner ore was crushed to a 2-inch size, fed into a log-washer and from this to a screen for sizing, and after sizing the various portions were carried past magnets by which the richer material was separated from the lean portions, which were carried to the waste piles. The finest portions passing the screen were washed by a stream of water to a separate magnet by which the ore was concentrated. The concentrates were then screened by a 10 mesh screen into finer and coarser portions. During the last two years all the ore was shipped to the furnace as mined, without further concentration than hand-picking.

The chemical character of the ore and the effect upon it of magnetic concentration has already been discussed on pages 52 and 69. All the analyses given on these pages were for commercial purposes and are only partial. Two complete analyses were made by the chemists of the Tenth Census[69], one of a selected sample of nearly pure magnetite (B) and the other of a mixture of magnetite and epidote representing a lean ore (A). These are quoted below. A third analysis of a selected sample was made by Mr. J. G. Fairchild of the United States Geological Survey. This is recorded below under (C) The figures under (D) represent the composition[70] of the shipping ore from the south vein of the Richard mine, Morris county, N.J.

[69] Willis. Bailey. Notes on samples of iron ore collected in North Carolina: 10th Census U. 8., vol. 15, p. 326. 1880.

[70] Bayley, W.C, Iron mines and mining in New Jersey: Geol. Survey of New Jersey: vol. 7 of the Final Report Series of the State Geologist, p. 113. 1910.

		A		B		C	D
Silica	(SiO_2)	29.99	29.99	5.27	5.27	14.28	8.48
Alumina	(Al_2O_3)	10.07	4.63	1.18	1.41	1.08	.86
Ferric oxide	(FeO)	25.05		62.57		50.35	55.99
Ferrous oxide	(Fe_2O_3)	18.93	3.78	26.68		28.30	26.98
Magnesia	(MgO)	1.78	.56	.55	.26	.62	1.89
Lime	(CaO)	11.33	4.62	1.46	.52	5.18	2.42
Soda	(Na_2O)		.07			.37	.33
Potash	(K_2O)		.10			Tr.	.19
Water at 110o	(H_2O –)	.37		.35		.04	.15
Water above 110o	(H_2O +)	1.49		.49		.17	
Titanium dioxide	(TiO_2)			.95		.12	1.01
Carbon dioxide	(CO_2)	.07		.08		None	
Phosphorus pentoxide	(P_2O_5)	.024		.007		None	1.54
Pyrite	(FeS_2)	.18		.20			
Nickel sulphide	(NiS)	.09		.04			
Sulphur	(S)					None	.008
Sulphur trioxide	(SO_3)					Tr.	
Vanadium pentoxide	(V_2O_5)					None	.08
Manganous oxide	(MnO)	.76		.22		.18	.02
Chromic oxide	(Cr_2O_2)					None	None
Baryta	(BaO)					None	None
Strontia	(SrO)					None	None
Flourine	(F)					None	.08
Total		100.134		100.047		100.69	99.948
Insoluble		43.60	43.75	7.20	7.46		
Iron	(Fe)	33.37		64.64		57.25	60.19
Sulphur	(S)	.128		.115			.008
Phosphorus	(P)	.010		.004			.672
Phosphorus ratio	(P:Fe)	.031		.006			1.115

The ore is notable for its low content of phosphorus and sulphur. It differs from the titaniferous magnetites in its low content of TiO_2 and in the absence of Cr_3O_2 (see page 19.) It is very similar to the ore in the gneisses of New Jersey, but contains less phosphorus and less titanium. Moreover, vanadium is present in the New Jersey ore and in all other New Jersey magnetites in which it has been sought, whereas it is absent from the Cranberry ore and, so far as known, from all other North Carolina magnetic ores.

The Cranberry vein, which encloses the deposit at the mine, has been traced for 6,400 feet by pits, cuts and underground working, so that it is regarded as being continuous through this distance. (Plate XV.) It is not so, however, with the workable ore. There are stretches of the vein that contain such small quantities of available magnetite that they may be regarded as barren. At other places the magnetite is in sufficient quantity to warrant mining. In all cases the ore-bodies lie within the vein, but they are separated from one another by lengths of the vein that are occupied mainly by gangue. (Plate XVI.) But even in these portions there is always a little magnetite in strings or threads connecting the larger masses (the ore-bodies) with one another. In

response to an enquiry made to President Howe of the Cranberry Furnace Co. the statement was made that in going north in the Cranberry mine, while at times the workings "passed through barren places where the ore almost entirely disappeared, it has in every case been the fact that it did not entirely disappear, and there was always a little thread of ore connecting together" the different deposits. Moreover, it is true that in each of the openings on Smoky Mountain, southeast of the mine proper, 'both at the south and north ends, as far as we have gone, there has been at least a little thread of ore left indicating the possibility of their leading on to another lens.'[71]

"The country rock surrounding the vein consists of a crushed and sheared complex of acid feldspathic rocks, some of which are dark gray and others almost white, occurring in alternating layers with black gabbroitic gneiss, believed by Keith[72] to be portions of the Roan gneiss which have been intruded into the more acid rocks. The lighter colored layers constitute by far the greater part of the complex, which has been called by Keith the Cranberry granite.[73]

The vein follows the schistosity of the country rock. It varies in width from a few feet to 200 feet and is extremely complex. It comprises a plexus of rocks in the midst of which occurs the commercial ore as a series of lenses, which so far as development has gone, appear to have no pitch. The plexus is cut by pegmatite and by veins of almost pure magnetite. The pegmatite cuts irregularly through the vein plexus twisting and turning in a complicated way and gradually fingering out. In some places it encloses lenses of ore and in others lenses of coarse, green hornblende. In places it cuts comparatively cleanly through the other rocks, often with only one sharp wall, rarely with both walls sharp. Usually the walls are indefinite—the pegmatitic material grading into gneiss, so that frequently there is a little seam of gneiss between the pegmatite and the vein matter.

The main portion of the vein, aside from the horses that occur in it and the veins of pegmatite and magnetite, consists of masses of hornblende, or of hornblende and magnetite, of hornblende and epidote, of epidote and magnetite, or of epidote and quartz, with occasional small quantities of molydenite.[74]

[71] Letter of Mr. F.P. Howe, President, dated Johnson City, August 27, 1919, and reply thereto by Mr. S.H. Odom, Superintendent of mine, dated Cranberry. August 28. 1919.

[72] Keith, Arthur. U.S. Geol. Survey Geol. Atlas. Cranberry folio (No. 90), p. 8, 1903.

[73] The Cranberry granite and Roan gneiss have been described on pages 39 to 46.

[74] Hamilton. S.H., Unpublished report to Tennessee Geol. Survey

Descriptions of the ore and of all the gangue rocks associated with it have already been given in a general way and their relations have been discussed on pages 48 to 67. It will not be necessary to repeat these statements but, since at some of the openings there are exhibited special features that throw considerable light on the method of origin of the vein, brief descriptions of these will be given at the risk of repeating some of the statements that have already been made.

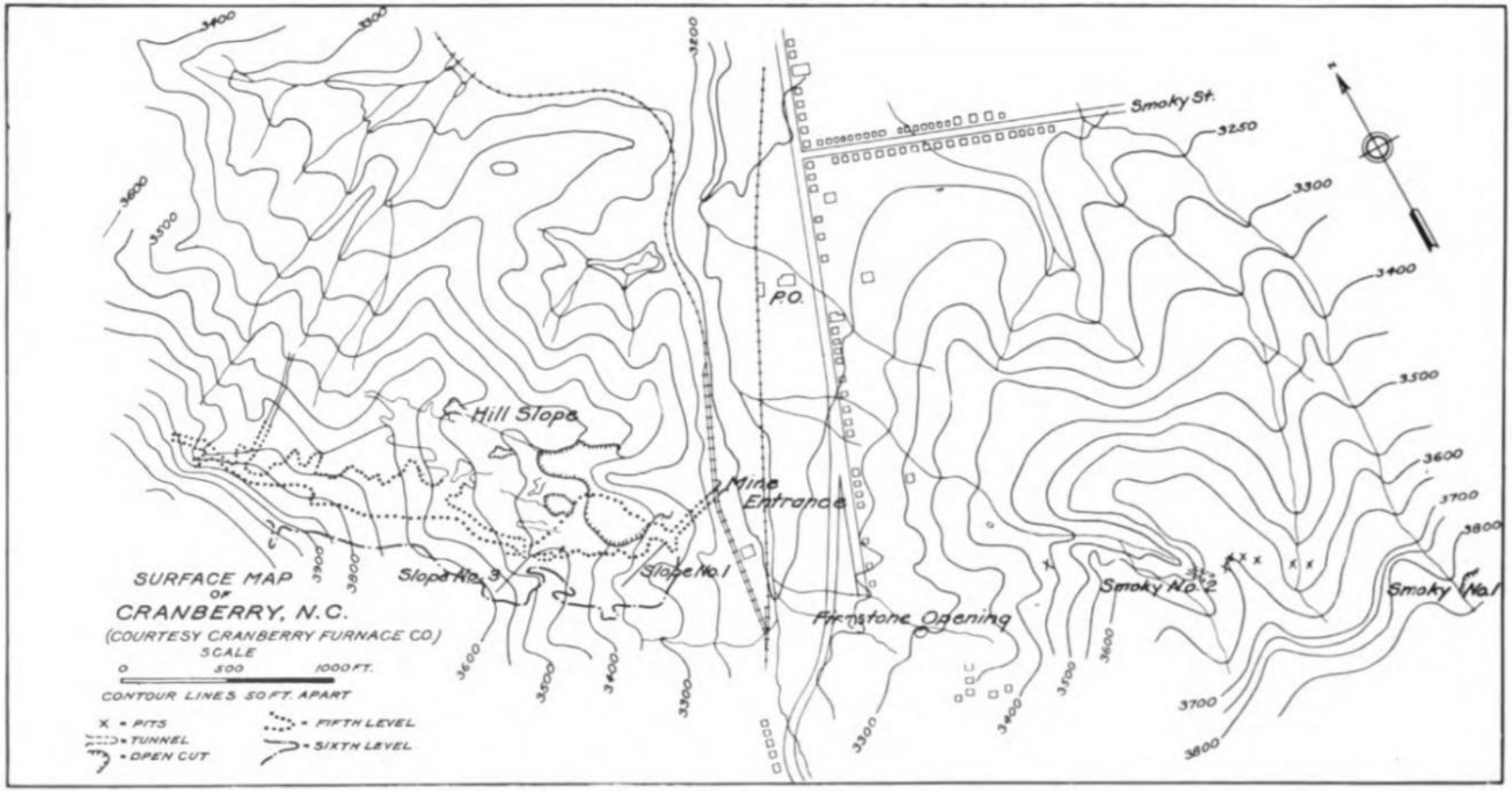


Figure 66. "Map of surface, Cranberry mine, Cranberry, N.C., with projection of underground workings. (Based on map by S.H. Hamilton, furnished by the Cranberry Furnace Co.)"

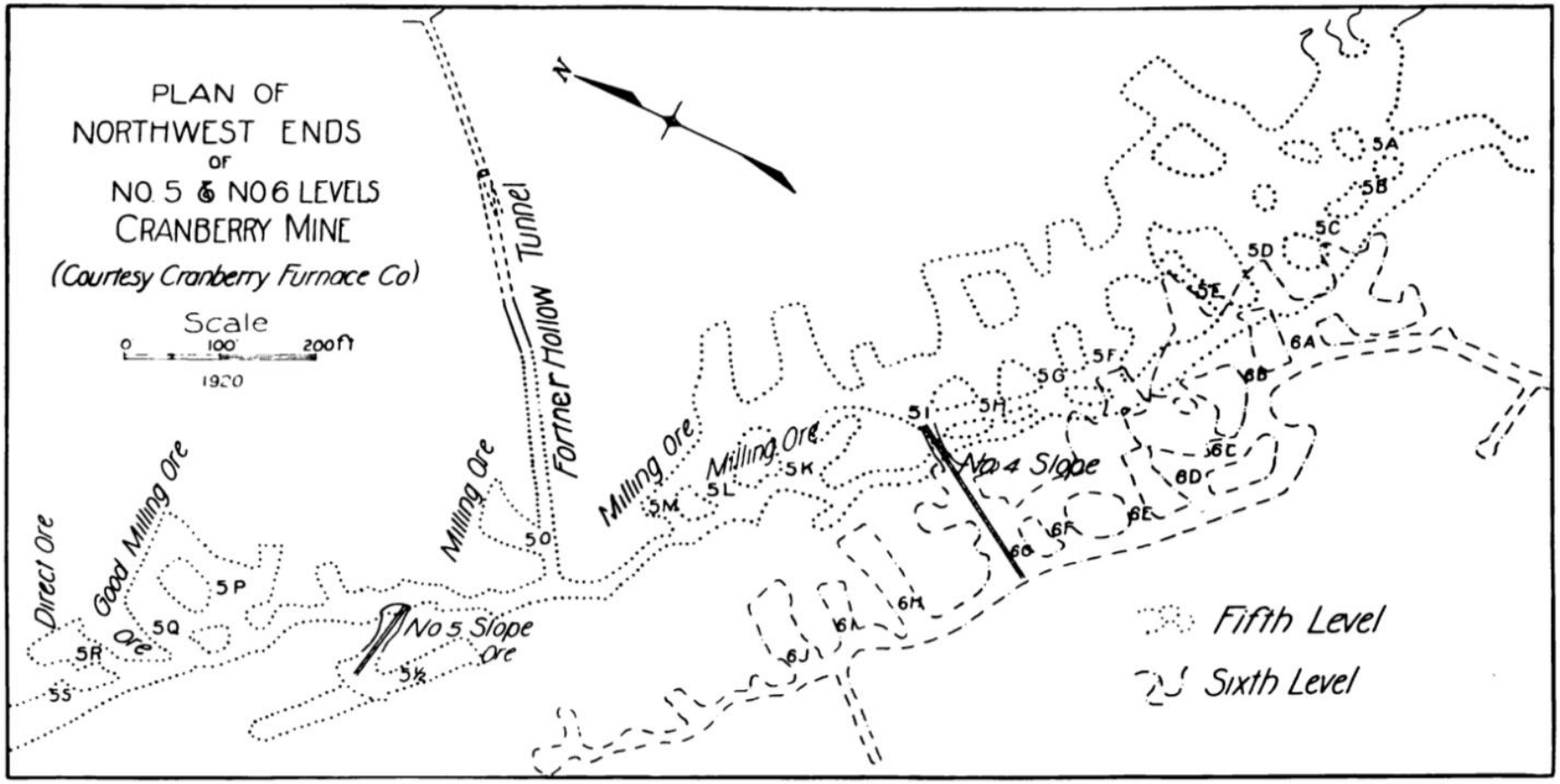
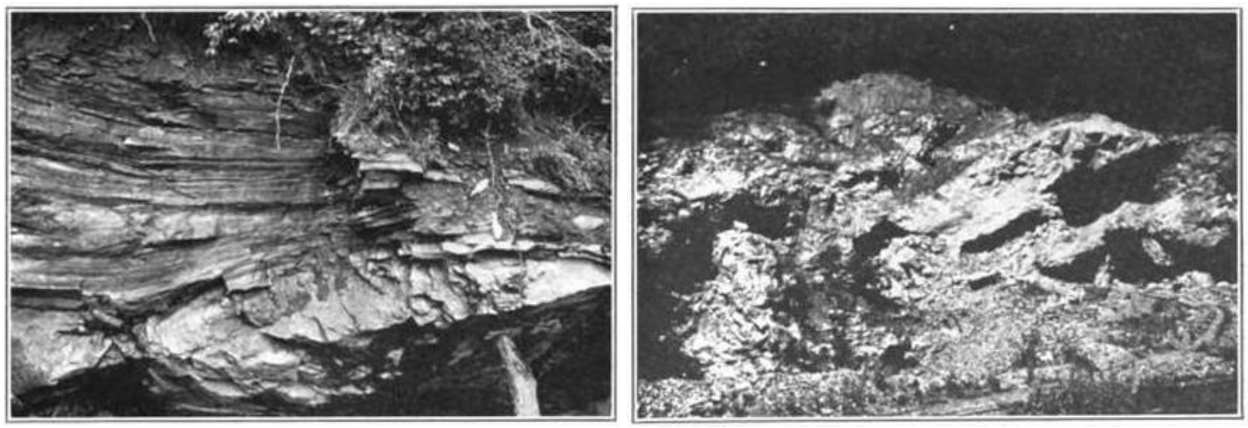


Figure 67. "Plat of workings, Cranberry mine, Cranberry, N.C. (Compiled from maps by the engineer of the Cranberry Furnace No. By courtesy of Pres. F.P. Howe.)"

Smoky No. 1

The southeasternmost opening in the Cranberry mine tract is at the head of a ravine on the north slope of Smoky Mountain about three-quarters of a mile southeast of the main opening of the mine. The exposed portion of the vein widens and narrows by rolls in the hanging-wall, in some places being only 4 inches wide. Its general dip is southeast and both hanging and footwall are Cranberry granite. (See Plate XVII, A, and page 45.) The vein contains a great deal of epidote. In some places it consists exclusively of epidote and darkgreen hornblende cut by quartz veins. Nearly everywhere it is bordered by a narrow seam of epidote rock which swells out at places into a coarse-grained aggregate of epidote, quartz, and idiomorphic hornblende. This coarse rock is plainly a pegmatite in which the feldspar has been changed to epidote. On the dump are fragments which show small masses of partially epidotized feldspar in the midst of nearly pure epidote-quartz aggregates. The hornblende is a greenish-black variety varying greatly in abundance in different portions of the pegmatite. It is entirely absent from some specimens, but it occurs in others forming crystal groups an inch in diameter, or, where in large quantity, forming lenticular masses that may be several inches or even several feet in length. Magnetite is always present where hornblende is abundant. It may occur in little streaks on the borders of the hornblende groups, or it may be scattered through them. Often the larger lenses are in reality granular mixtures of hornblende and magnetite, or granular aggregates of hornblende with little lenses of magnetite scattered through them. In some cases also short thin seams of magnetite and small lenses of the same mineral are to be found in the midst of the epidote, but this is not common. The magnetite and hornblende are so intimately associated that it is difficult to escape the suspicion that they are genetically connected."



(A) (B)

Figure 68.

"(A) Smoky No. 1 opening, Cranberry mine, showing platy structure of hanging-wall granite.
(B) Part of wall, open cut, Cranberry mine, showing irregular distribution of ore. All the rock in view is vein-filling.

Plate XVII.

Another feature that is prominent in all the pegmatite in this opening is the apparent schistosity of the rock. The lenses of hornblende, of magnetite and of the mixtures of the two and

large isolated crystals of hornblende are all elongate in the plane of the vein. The quartz, however, rarely shows this parallelism to a marked degree and the epidote never.

The ore is mainly toward the center of the vein between the streaks of epidote rock near its borders. It is the usual mixture of hornblende and magnetite cut here and here by strings of nearly pure magnetite. (See pages 52 to 58.) In the midst of the vein is a banded gneiss that looks like a schistose diorite, and it is noticeable that the feldspar in it is pink and shows little trace of epidotization. The miners state that the rock is a horse in the vein, which plays out along its strike and often continues in the ore as partings. Moreover in this opening a small diabase dike cuts the ore lengthwise, but this is not significant, as similar dikes occur in the granite at some distance from the vein.

The material of the 'horse' is a distinctly gneissic, somewhat fissile, gray and white mottled rock, with occasional white feldspar streaks and chlorite partings parallel to the schistosity. The mottlings are due to the presence of fragments of decomposed plagioclase (mainly oligoclase), scattered through a dark-gray matrix. The centers of the grains contain numerous small prisms of a light-colored epidote (probably zoisite), but they are surrounded by broad rims of newer plagioclase entirely free from decomposition products. The feldspar fragments are embedded in an aggregate of quartz, feldspar, plates and spicules of hornblende, and nests of yellow-green epidote. The quartz and epidote form a mosaic and the hornblende occurs as clumps in this mosaic as though representing grains of some mineral that has otherwise completely disappeared. Although the greater part of the hornblende is in the mosaic many spicules extend into the rims around the larger grains of feldspar and some penetrate into their altered nuclei. Many of the feldspar grains are granulated on their edges and nearly all show curved twinning lamellae.

Horses of this kind are not notably different from the more common varieties of Cranberry granite. They are apparently portions of the granite that have been enclosed in the vein and greatly metamorphosed. Their principal difference from the granite is in the greater proportion of hornblende and epidote in them.

Mention has been made of the fact that as a rule there is a narrow layer of epidote on the outside of the vein. This is usually between the ore and the walls; but at one place a little lens of ore, composed of the usual granular mixture of hornblende and magnetite, separates the epidote from the hanging wall. Between the ore and the wall is a gouge of chlorite mixed with particles of magnetite.

Smoky No. 2

The next important opening on the mountain is the pit and tunnel known as Smoky No. 2. It is about 1,100 feet northwest of the opening just described and 250 feet below it. At the end of the tunnel the vein can be seen to be 8 feet wide and to dip about 20° SW. The dip rises to 32° in some places, said to be due to rolls mainly, if not exclusively, in the hanging-wall. Between the Cranberry granite and the vein-mass on both walls are gouges of shaly or slaty chorite schist. This gouge is about l½ inches thick on the hanging-wall and consists almost solely of chlorite. The ore-matter is composed of a mixture of magnetite, hornblende, epidote and quartz, cut by veinlets of magnetite, and here and there by veinlets of epidote. The richer portions contain a greater number of magnetite veinlets or a few larger veins. Some of the latter are themselves cut by small calcite veins and by tiny streaks of pyrite. Ore of this kind is massive, or very slightly schistose. It is composed of large crystalloids of magnetite and in addition garnet in some places. A microscopic description of the ore is on page 56. A parting in the ore consists of very fine-

grained epidote with parallel streaks of quartz. Its surfaces are covered with a thin coating of the same chloride gouge that occurs on the walls of the vein, indicating movement in the ore-body after it became solid.

On the dump at the tunnel are many large fragments of ore and vein-rocks that afford a better view of the relations of these to one another than can be seen on the walls of the tunnel, and also great fragments of a very feldspathic weakly schistose gneiss that is said to occur as a 'horse.' The feldspar of this gneiss is pink and fresh, and the rock shows no trace of epidotization. Under the microscope the rock is seen to be composed of large orthoclase and oligoclase or andesine grains, broken across, crushed on their edges, and often separated into sharp-edged fragments, surrounded by a quartz-feldspar mosaic containing numerous small plates of a yellowish-green biotite, that lie between the larger grains and wind around them. Other sections contain a great deal of granular epidote and a few wisps of green hornblende. The rock apparently is a crushed Cranberry granite.

The greater portion of the vein-filling is a foliated gneiss composed of alternating feldspathic and hornblendic layers. The feldspathic layers appear to have intruded a series of alternating layers of hornblende schist, sugary quartz and finely granular epidote making up a portion of the vein mass at this place. Certain of the feldspathic streaks appear to extend into the schists and to terminate in quarz-epidote veins; in other plages they swell into pegmatite lenses.

Within this vein-mass are lenses of quartz and veins of granular epidote ranging from a tiny fraction of an inch to an inch or more in thickness. In many places, especially where they are in contact with hornblende, the epidote veins are bordered by narrow zones of magnetite. Lenses and veinlets of pure magnetite also occur in the hornblende layers. In some places the magnetite lenses seem to be isolated but in most places they are connected by small veins of magnetite. Those portions of the hornblende layers that are most closely crowded with the lenses and veins constitute the commercial ore. In some specimens the hornblende is extremely fine-grained and schistose, and where it breaks away from lenses of magnetite embedded in it the contact surfaces are seen to be coated with chlorite. Moreover, much of the hornblende in the schist layers is also apparently chloritized. Evidently there has been movement within the vein since its solidification. This is also evidenced by the fact that the pegmatite lenses which are common in the foliated gneiss are in some places crushed into their component feldspar and quartz grains, so that their grains, especially the feldspar grains, are separated from the main mass of the pegmatite and surrounded by films of the hornblendic schist.

In the opening above the tunnel the vein exposed at the back and on the sides of the opening consists in the main of the same coarse-grained hornblende-epidote filling as elsewhere; but in addition there is present much garnet. Near the hanging-wall are several distinct veins of epidote cutting the vein-mass, and between these and the wall the usual vein matter is replaced by a compact aggregate of garnet, hornblende, feldspar and calcite, in which the hornblende appears to be the oldest component.

A slide made across the contact of a small epidote vein and the coarse hornblende mass shows the hornblende mass to consist of a fine-grained mixture of uralite, epidote, quartz, magnetite crystals, calcite nests, and veins and lenses of quartz mosaic. The hornblende, however, frequently polarizes uniformly over large areas, and produces the coarse texture noticed in the hand specimen.

The epidote vein is a granular aggregate of yellow-green epidote crossed by veinlets of quartz mosaic between the grains of which in places is a filling of calcite. There is no sharp contact between the epidote vein and the hornblende mass. In some places there is a thin seam of

quartz between the two; but in most places the contact is simply a plane on one side of which there is an abundance of amphibole and on the other side none.

Toward the center of the vein, but distributed rather irregularly through it. are masses of lean ore consisting of a granular aggregate of magnetite, hornblende and epidote and masses of what was originally a coarse pegmatite but which now is a very coarse aggregate of hornblende and epidote, with hornblende individuals often half an inch long, containing numerous tiny grains of magnetite. Here and there a garnet is associated with the epidote and scattered through the mass are tiny veins of calcite. Calcite is especially noted on joint cracks, but it occurs also scattered among the epidote grains. Quartz lenses a few inches long are not uncommon in the midst of the hornblende. Near them are often little pyrite cubes. In certain portions of the vein the magnetite grains in the hornblende become larger. They group into little aggregates of lenses and the mass becomes a lean ore. Through this calcite veins run in all directions.

Sections from an irregular mass of epidote and hornblende taken from about the center of the vein when viewed under the microscope show large masses of pure epidote, cut by veinlets of quartz and epidote and surrounded by a mixture of epidote, hornblende, quartz, and feldspar containing little nests of calcite. A few little crystals of magnetite are scattered through the hornblende-epidote mixture and a thin border of garnet in a few places lies between the large epidote areas and those characterized by the presence of hornblende. Quartz veins and epidote veins cut through the rock in various directions. The areas in which epidote alone, or epidote and calcite occur and those in which hornblende is prominent, are so distributed as to suggest that the former represent feldspar and the latter pyroxene. Thus reconstructed, the rock appears to have been a coarse augite-syenite—probably a pegmatite.

Lean ore masses scattered through the vein are composed mainly of uralite, epidote, and magnetite. The uralite and epidote are in areas that suggest a granitic rock. The only differentiation observable in it is that in some areas the light colored granular epidote is free from hornblende and in others one-half or more of the mass consists of crystalloids of hornblende inclosing grains of epidote, feldspar, and calcite. The magnetite is in much smaller quantity than would be thought from a study of the hand specimen alone. It occurs in a few irregular grains surrounded by narrow zones of light colored epidote, even when present in areas characterized by abundant uralite.

Firmstone opening

Another opening, the Firmstone opening, at the base of the mountain, about 1,300 feet northwest of Smoky No. 2, is an old pit on the dump of which are many large fragments which show that the conditions in the vein at this point are the same as at Smoky No. 1 and Smoky No. 2. The vein does not change in its character through this length of half a mile.

Mine opening

Naturally, the best exposures on the Cranberry property are at the mine, where there is a large open cut on the east slope of Cranberry Hill (Plate XVI), an eastern spur of Hump Mountain, and a tunnel at its base. The mine is entered by the tunnel, which runs southwest to the vein, at an elevation of 3,211 above sea level. From the junction the vein is followed along its strike, which is N. 34° W., and the mixed ore and rock are taken out as the advance progresses. Above this level are others which were abandoned as the ore was removed. The ore is now being worked upward and downward from the tunnel level and this at the same time is being advanced along the vein by stoping at its end. From the southeast part of the mine a slice of mixed ore and

rock has been removed which was about 200 feet thick, 800 feet long, and 300 feet high (measured on its dip). As the work advanced along the strike of the vein the ore body alternately widened and narrowed. It also widened and narrowed on the dip. In other words, that portion of the vein that is minable occurs in lenses surrounded by portions that are not minable under present conditions. (Compare Plate XVII, B.) These non-minable portions contain magnetite, but not in sufficient quantity to pay for working. If an efficient concentrating process were available it is probable that much more rock might be removed from the vein and treated with profit, and it is possible that the entire contents of the vein might become available for concentration, in which case the lens-like character of the ore body might not be so distinct.

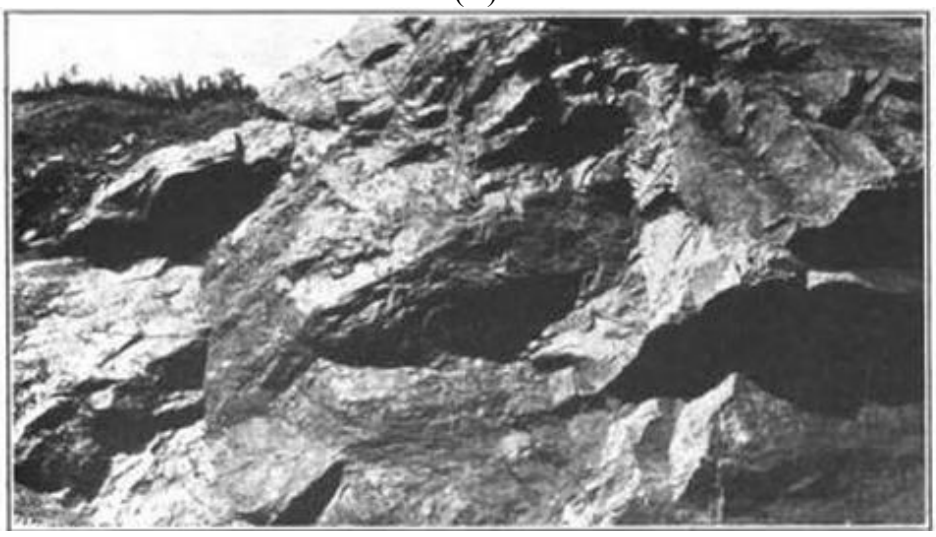
The portions of the vein that are now minable are certainly lenticular. (See plat, Plate XVI.) The lenses are about 800 feet long and 200 feet wide at their widest part. Their heights in the plane of the dip are not known but are in the neighborhood of 500 feet. So far as present observations are possible the lenses appear to have no pitch. They are separated from one another partly by pinches in the vein but more commonly by the narrowing of the richer portion of the veinfilling. However, they are connected by thin stringers of ore, which in every case thus far noted, lead from lens to lens. This is true not only for that portion of the vein in the neighborhood of Cranberry, but apparently it is true also for its northwestern extension as far as Shell Creek. Mr. Hamilton, who has investigated this portion of the vein by magnetic methods, states that a narrow line of attraction can be detected following the course of the vein and that at irregularly spaced intervals this line expands to broader areas. In the areas of most pronounced attraction are the Cooper, Wilder, Red Rock, Patrick, Teegarden, and Ellis explorations.

Explorations in the mine have not shown the downward termination of the lenses nor have they outlined their limits in all other directions. The mine plat (Plate XVI) shows that the general shapes of the horizontal sections of the ore-bodies are those of horizontal sections of lenses, but no complete vertical sections are available. The floor of the lower level of the mine is on ore, but drill holes that were sent downward to determine the extension of the ore-bodies down the dip are reported to have shown very little ore in this direction. It is reasonably certain that the ore occurs in lenses and that the lenses do not terminate abruptly with depth. If the source of the ore was, as supposed, a subterranean magma (see page 68), it is probable that the deposits extend downward for some distance. On this assumption there should be ore below the present floor of the mine. It is upon this supposition that the estimate of reserves given on page 78 is based.

The best exposures of the vein are in the large open cut on the slope of the hill. (See Plate Mil, A, Plate XVII, B, and Plate XVIII.) The vein here is about 80 feet wide. On the walls of the cut are excellent exhibitions of the relations of the various phases of the vein-filling to one another that have already been described (pages 43 to 67.)”

PLATE XVIII.

(A)



(B)

Figure 69.

"(A) Part of wall of open cut, Cranberry mine, Cranberry, N.C., showing irregular distribution of pegmatite in the vein-filling.

(B) General view of wall of same cut, showing hanging-wall of foliated Cranberry granite.

Large 'horses' of rock occur in the vein, and on the wall of the cut sections of some of them can be seen. Some of the specimens on the dumps are not very different in appearance from

those taken from exposures of the Cranberry granite. They are so like the schistose portions of the Cranberry granite that they are believed to be splinters of the granite mass that were split off the main mass at the time the vein was formed. Other specimens of schistose granites are streaked porphyritic gneisses with here and there alternating layers of darkgreen hornblende like that associated with the ore. These were apparently a part of the vein-filling. They consist of zoisitized plagioclase fragments in a schistose matrix composed of small fragments of plagioclase, elongate grains of newly crystallized, striated and unstriated feldspars, a little quartz, some uralite, considerable granular colorless epidote and a few streaks of yellow-green epidote. (Plate XX, B.) Nests of calcite are scattered through the matrix irregularly. The hornblende flakes and epidote streaks wind sinuously between the large feldspar fragments and are separated from one another by a fine-grained mosaic of quartz or of quartz and feldspar. Much of the colorless epidote is in tiny grains and crystals scattered through the feldspar, but in some places the epidote particles are arranged in thin straight lines following definite twinning striae as though certain of the plagioclase lamellae had been more susceptible to change than others.

The general features of the rocks constituting the vein-filling have already been described (see page 48), but there are certain additional features exhibited by some of the specimens in the rock pile at the bottom of the incline that should be referred to briefly. One of the more abundant rocks in the pile is a coarse-grained hornblende pegmatite cutting a coarse hornblende rock. In most specimens this has the character already described (page 62), but in some specimens magnetite occurs abundantly as irregular masses in the hornblende. Where not scattered indiscriminately through the hornblende in the pegmatite it appears as a selvage between the pegmatite and the coarse hornblende rock through which the pegmatite cuts. The hornblende rock also often contains little blebs of magnetite and is traversed by veinlets of the same mineral.

A few fragments of pegmatite are essentially magnetite pegmatites. They differ from the more common hornblende pegmatites solely in the fact that magnetite has replaced most of the hornblende. The microscope shows that there still remains considerable hornblende in the black masses within the pegmatite but it is so completely saturated with magnetite, that the hand-specimen appears to consist exclusively of partly epidotized feldspar and magnetite. There is no magnetite present, however, except in aggregates with hornblende. It is not present in the feldspar unmixed with hornblende.

In many specimens the proportion of magnetite in the pegmatite is so great that the mass becomes ore. In these the feldspar is limited to a few ill defined crystals mixed with coarse hornblende crystalloids and a few little elongate grains of the same mineral forming lenses embedded in an irregular, more or less schistose aggregate of hornblende and magnetite, traversed by numerous veinlets of magnetite.

In a characteristic thin section are large plagioclase fragments crushed on their edges to small fragments which are mingled with grains of epidote and wisps of amphibole to form a matrix in which the large fragments are usually embedded. Often the large fragments are cracked and their parts slightly displaced, their twinning striations at the same time being bent and twisted in a complicated way. Between the fragments of the feldspar is a mixture of small quartz grains and epidote, the latter of which is not only present in small equidimensional grains but also in elongate grains and in large clusters of grains. The quartz grains are slightly lenticular. Their long axes are approximately parallel to the elongation of the epidote and to that of the hornblende, and as a result the rock is schistose. The epidote and much of the quartz are secondary as they both form little veins in the feldspar and some of the more compact hornblende. A little of the quartz is probably original. This is now represented by a few grains a

little larger than the average that exhibit shadow extinction. Crystals and groups of crystals of epidote are also scattered through the feldspars, and veinlets of the same mineral occur in the cracks between their dissevered parts. Between neighboring large grains are often thin seams of amphibole inclosing in places large nests of bright-yellow epidote.

In the richly magnetitic pegmatites the magnetite is commonly associated with the hornblende. It is present either as comparatively large masses comparable in size with the feldspars and pyroxenes beforj they were broken, or as smaller sharp-edged pieces scattered througli the aggregate of uralite, quartz, feldspar and epidote that lies between the large broken grains. In many places the sharp-edged pieces appear to be fragments of large grains that have been moved apart for considerable distances. In other places they are so close that they can be fitted together into a single grain. Where close together they are separated from one another by narrow cracks, in which may be a little brown biotite or a little uralite. The larger pieces have irregular boundaries as though they had been corroded, and it is noticeable that any feldspar in contact with them has been completely changed to epidote. In some sections are also a few crystals of apatite.

Allanite is the only other mineral that has been seen in any section of pegmatite. It is in crystals several millimeters in length, that seem to have suffered no deformation and but very slight alteration.

Where the feldspar of any variety of the pegmatite is in contact with masses of hornblende, the feldspar near the contact is commonly completely changed to epidote whereas that an inch or more from the contact is white and fresh and shows no trace of epidotization. The epidotizing solutions appear to have emananted from the hornblende, which may indicate that the hornblende was intruded after the pegmatite.

Most fragments of the pegmatite on the dump are of the kind described. There are, however, others of a very quartzose type, in which the quartz is blue. This variety contains no hornblende, but is composed of quartz and feldspar almost exclusively. As the rock shows very little schistosity and its components show no evidence of crushing, it must be a much younger rock than the more common syenitic pegmatite. (Compare Plate VIII, B.)

The garnet rock that occurs so abundantly in Smoky No. 2 (page 110), is fairly abundant on the dump of the mine. In part it is associated with hornblende and in part with magnetite. In the mine it is said to be always close to pegmatite, but the exact relations of the two are not more definitely known. Whether associated with hornblende or magnetite the garnet makes up by far the greater part of the mass. As a little feldspar and epidote are present in all specimens of the garnet rock it is probable that the rock is either a part of the pegmatite or a contact metamorphic product of some pre-existing rock.

The hanging-wall rock in the mine is a chloritic gneiss cut by a fewquartz veins. (Plate XVIII, B.) It is apparently a very much sheared phase of one of the darker layers of the Cranberry granite. An analysis by Dr. J.I.D. Hinds of the Tennessee Geological Survey yielded:

Partial analysis of gouge in hanging-wall of vein at Cranberry mine, Cranberry, N.C.

Silica (SiO_2)	58.46	Magnesia (MgO)	3.10
Alumina (Al_2O_3)	19.52	Lime (CaO)	.96
Ferric oxide (Fe_2O_3)	11.28	Phosphorus pentoxide (P_2O_5)	.47
Ferrous oxide (FeO)		Water (H_2O+)	2.78

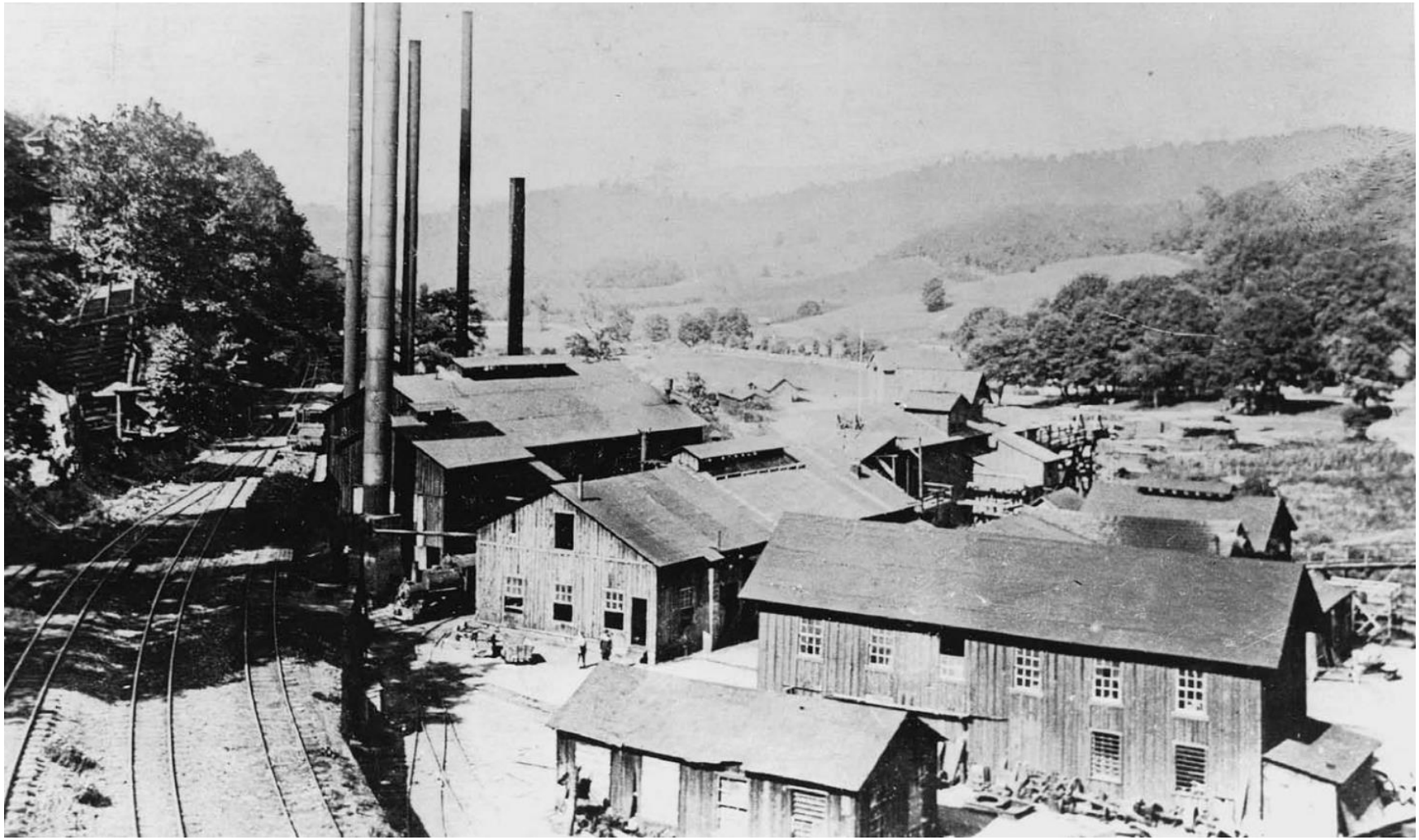


Figure 70. "Cranberry mine is still a busy place in the 1920s. Cranberry Iron & Coal's 0-4-0 Porter is heading back into the mine through the main tunnel, under the ET&WNC mainline. This is a very late view of the mine, most likely in its last phase before closing. Note that an additional boiler and stack has been added to the large, two story boiler house directly behind the dinky. Edith Cornett Collection, (Copy photo by Cliff Ward)." Chris Ford captioned this photo: "View from hillside of mine operations, circa 1925".[206]

Figure 71. “The engine house and mine are in the foreground of this 1920s view of Cranberry looking northeast. James T. Dowdy Collection.”[207]

Figure 71A. “Cranberry, NC Iron mining village, Avery County, NC, 1925”, photograph by Herbert Hutchinson Brimley.[208]

Figure 72. Cranberry, 1925, photograph by Herbert Hutchinson Brimley.[209]

Figure 73. Cranberry, circa 1925, by Chris Ford.[210]

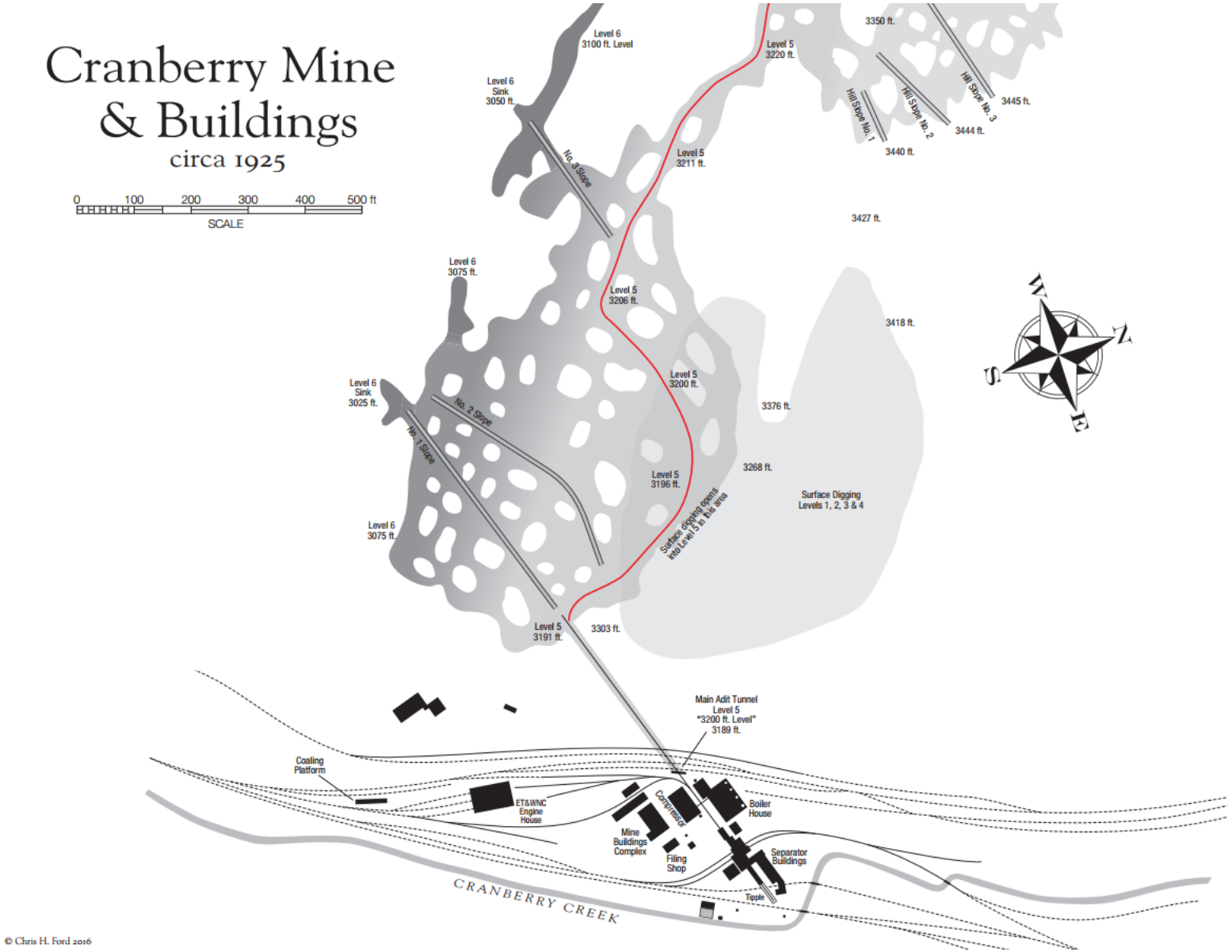


Figure 74. Cranberry, circa 1925, by Chris Ford.[211]

1925. The Cumulative Daily Digest of Corporation News.

"Mine to Reopen. – May Purchase Railroad. – After being closed down for two years definite announcement is made that the Cranberry iron mine in Avery County, N.C., which it is reported has been purchased by Henry Ford, will resume operations again on Sept 1 next. Reports current at Johnson City, N.C, state that Mr. Ford has also purchased the East Tennessee & Western North Carolina Ry. are given additional credence because of the announcement that Cranberry iron mine will open. The mine and railway have been owned for years by the same interests. It is known that Mr. Ford had been anxious for a long time to own an iron mine in the South. Wall St. News, Aug. 11. 1925, p. 1."[212]

1926 – 1928. The Mining Industry in North Carolina during 1926.

"Iron

In 1926, there was a sharp decline in the production of iron ore in this State. Of the eight companies which have operated in North Carolina, only two of them reported a production. Two types of ore were mined, hematite and magnetite.

The chief producing mine Of the State is the mine at Cranberry, Avery County, owned and operated by the Cranberry Furnace Company of Johnson City, Tennessee…

'The method of mining has been governed by local circumstances and advantage has been taken of the fact that the walls are so firm and rigid as to require only a minimum of timbering. The earlier operations consisted of quarrying the ore along the great outcrop by means of open benches, assisted by the steep easterly slope of the hillside. Four such benches were originally worked, about fifty feet apart vertically, the lowest being about 100 feet above the level of Cranberry Creek where the creek flows past the mine buildings. By degrees, following the quarrying operations, the ore was followed into the hillside by means of slopes and trackways along the foot wall. The ore was hauled out over these trackways in cars by means of small air-driven hoists, and dumped through chutes and transfer-bins by successive stages of traming and dumping until it reached

'The blast furnace plant of the Cranberry Furnace Company was originally built in 1892. After a rather unsuccessful career and having passed through the several ownerships, the plant was bought by a subsidiary Of the Cranberry Iron and Coal Company, a corporation controlled by Pennsylvania capital, which owns the celebrated Cranberry Mine at Cranberry, North Carolina, the East Tennessee and Western North Carolina railroad that runs from that point to Johnson City, Tennessee, a distance of thirty-five miles, and the Linville River Railroad, running from Cranberry to Boone, North Carolina, a distance of thirty-two miles.'

The blast furnace has a daily capacity of 300 tons production of pig iron. The present owners have put it into first class condition. At the end of 1926 the mine had been cleaned out, the waste or gangue crushed and sold as road material for paving the Appalachian Scenic Highway and the streets of Boone. The production for 1928 will probably be as large as in any year in the history of the mine.

'The Cranberry Furnace Company manufactures low phosphorous pig iron exclusively from the ore from the Cranberry Mine, with the exception of a small quantity of ore imported from Canada. This grade of pig iron is the best that is manufactured in this country and goes exclusively into the manufacture of high class steel.' (Sears)

The production of iron ore in 1926 amounted to long tons. This production came from Avery and Cherokee Counties

Production of Iron in North Carolina
1921 – 1926, Inclusive

Year	Amount Long Tons	Year	Amount Long Tons
1921	383	1924	12,525
1922	19,279	1925	22,011
1923	59,648	1926	15,198

As shown by the table above the production for 1926 was tons less than in 1925. This decrease in production was due to the closing of the plant for a great part of the year to the production of iron ore but during most of that time the plant produced road material in the form of crushed stone and rock dust."[213]

1927 – 1928. Mining Industry in North Carolina during 1927 and 1928.

"Production of Iron in North Carolina
1923 To 1928, Inclusive

Year	Ton	Value	Value per Ton
1923	59,648	$161,603	$2.70
1924	12,525	32,512	2.58
1925	22,011	49,511	2.25
1926	15,198	31,645	2.08
1927	32,528	81,753	2.51
1928	*	*	*

* No Production.

As shown by the above table, the production of iron for 1927 showed an increase of 17,330 tons and $50,108 in total value. The price per ton increased 43 cents which is probably the cause of the increase in tonnage. The production came from the Cranberry Furnace Company, Cranberry, N.C."[214]

1929. "Cranberry, North Carolina," by John R. Waite.

"The mines shut down forever in 1929, when the Cranberry Furnace in Johnson City was shut down for a final time. One reason for the final closure was that miners, working in the lower level, had broken into an underground water reservoir and the entire lower level of the mine flooded. A lot of mine equipment ended up under water and unrecoverable; despite attempts to pump the water out of the mine. It wasn't long before most of the mine buildings were gone…

In the late 1920s and 1930s, North Carolina was busy constructing and improving roads in the mountains. The old mine crusher was used to crush rock for road construction. The narrow gauge hauled the rock to the crusher. The gravel was loaded into trucks and hauled to the construction sites."[215]

1930. Mining Industry in North Carolina from 1929 to 1936, Inclusive.
"On account of the depression, the Cranberry Iron Mine closed, and no production has been shown since 1930. The gangue and stone from the Cranberry Mine has been used as road material in the western counties. However, no iron ore has been produced from that mine in recent years."[216]

Late 1930s. "Cranberry, North Carolina," by John R. Waite.

"Cranberry Furnace Company was reincorporated as the Tennolina Corporation in the late 1930s. All the Cranberry properties were transferred to the new corporation. Tennolina sold the surface rights to 1600 acres at Cranberry to J.A. Taylor. Taylor then sold some of the land to Mead Corporation of Silva, North Carolina for the timber. They also sold most of the residences and small parcels of land to individuals."[217]

1943 – 1946. The Mining Industry in North Carolina From 1937 to 1945.

"Cranberry Area. – The Cranberry Mine is in Avery County, about 1½ miles south-southeast of the village of Elk Park, and 2½ miles from the Tennessee state line, in an area of extremely rugged topography.

During the war period, magnetic surveys were made in the Cranberry area, by the United States Geological Survey in the spring of 1943, by H.A. Brassert Company in the autumn of 1943, and by the United States Bureau of Mines during 1944 and later years.

Diamond drilling was started by the Bureau of Mines at Cranberry on November 25, 1943, and up to August 26, 1944, a total of 9,892 feet had been drilled in 12 holes. (See U.S. Bureau of Mines Report of Investigation 4274). These operations were continued at different times into the latter part of 1946. A preliminary estimate, based only on the first twelve holes and what might logically be inferred from other information, indicates that the available ore reserve is at least 1,600,000 tons.

In March, 1944, construction was begun on a pilot plant at Cranberry for the production of high-grade magnetite concentrates for use in the Bureau of Mines' sponge iron pilot plant at Salisbury. The mill was completed in May, 1944, and was operated intermittently until December, 1944.

Grinding to 65-mesh or finer was required to liberate the magnetite and gangue minerals, after which concentrates assaying 70.3 per cent Fe, 0.035 per cent S, 0.002 per cent P, and 1.10 per cent Si02 were obtained by passing the ground ore through two Crockett Type-K, wet magnetic separators in series. The recovery of magnetic iron was approximately 94 per cent and that of the total iron was approximately 89 per cent. The ratio of concentration amounted to 2.65 tons of ore assaying 30 per cent total Fe to 1 ton of concentrates.

A flow sheet for a 100-ton mill, estimated to cost $80,344 was suggested. The direct operating cost for such a plant is estimated to be $0.84 per ton of feed, not including mining costs, amortization taxes, interest, insurance, or freight charges. Results of the Bureau of Mines work may be found in their Reports of Investigations 3980 and 4274…

In the spring of 1944, tests on Cranberry concentrates were carried out by the Bureau at the plant of the Isenhour Brick and Tile Company, in Salisbury, Rowan County. These tests were highly successful and came up to expectations in every respect."[218]

Figure 74A. “View of the remains of the mine operation from hillside, circa 1940” by Chris Ford[219]

1944 – 1945. Pilot-Plant Production of High-Grade Magnetite Concentrates, Cranberry, N.C.

"Introduction

The iron-ore deposits near Cranberry, N. C, were worked as early as 1820, and records show that to date at least 1,500,000 tons of ore has been mined. The early operators depended on selective mining and hand cobbing to yield a product containing 40 to 50 percent iron. Later, a magnetic concentrator was erected by the Cranberry Furnace Co. and was operated periodically until 1930. The magnetic cobbing method employed yielded satisfactory concentrates, but the plant was shut down because costs were too high.

Early in 1944, in connection with the sponge-iron program of the Bureau of Mines, North Carolina and Tennessee were surveyed for the purpose of finding a readily available source of high-grade iron ore for use in the experimental production of sponge iron at Salisbury, N.C., and samples from various sources were tested in the laboratory. The Cranberry ore proved to be best with respect to grade of magnetite concentrates produced, and it was decided that a pilot mill should be built on the Cranberry mine property and that the concentrate made there should be shipped to Salisbury for direct-reduction tests in a commercial brick kiln…

Description of Ore

The Cranberry ore is mainly a mixture of hornblende and magnetite, with epidote, pyroxene, quartz, and minor amounts of feldspar, mica, pyrite, gypsum, calcite, and apatite. It is hard and abrasive, especially when large amounts of epidote are encountered.

A chemical analysis of the sample used in laboratory tests is shown in table 1.

Table 1. - Partial chemical analysis of heads sample

	Percent
Fe	48.1
Insol	41.0
SiO_2	17.8
CaO	8.4
TiO_2	.17
S	.14
P	.005

Description of Pilot Mill

The primary objective in mill design was the simplest possible construction which would produce a magnetite concentrate of at least 70 percent soluble iron content, and in large enough quantity to satisfy the requirements of the Bureau of Mines sponge iron plant at Salisbury, N.C.

Due to manufacturing difficulties during the, war, two 12-inch, commercial, type-K, Crockett magnetic separators intended for use in this operation were not delivered until several months after the rest of the milling equipment was ready to operate, Consequently, during the majority of the mill run a 6-inch, laboratory, Crockett magnetic separator and a No. 6 Wilfley table, which were available, were used to concentrate the ore. The capacity of these machines was small, and a continuous operation was not feasible owing to the necessity of passing the concentrates back through the separators two or three times in order to make a product of the desired grade.

However, after the 12-inch Crockett magnetic separators were installed, the operation was satisfactory, and the milling costs were maintained at a level commensurate with most pilot-plant operations. The mill, when completed, had a capacity of 40 tons of crude ore per day and produced a concentrate containing a minimum of 70 percent soluble iron. Recovery of magnetic iron averaged approximately 91 percent. The pilot-mill flow sheet is shown in figure [75].

The classifier overflow went directly to a 12-inch, Crockett, type-K, magnetic separator; the concentrate from this machine was retreated in a second separator of the same type; the middlings from both machines were returned to the grinding circuit, and the tailings from each machine were discarded.

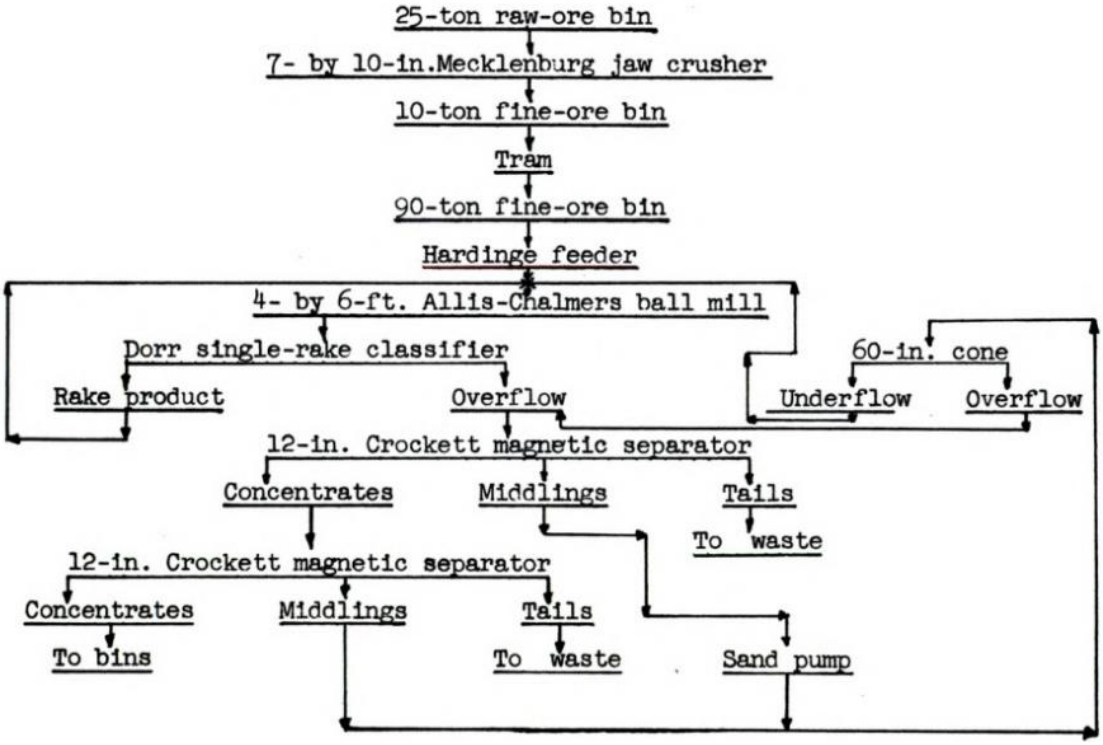


Figure [75]. Pilot-mill flow sheet.

Laboratory Tests on Pilot Mill Products…

Suggested Flow Sheet for Concentrating Cranberry Ores

Upon the basis of results obtained, from the laboratory, and pilot-mill tests of Cranberry ore, a suggested flow sheet for a mill of 100 short tons capacity per 24 hours is shown in figures [76 and 77]. The suggested mill would employ magnetic cobbing before fine grinding and final concentration and would produce a concentrate of 70-percent iron or over with a recovery of over 90 percent of the magnetic iron.

Estimated Cost of Suggested Mill

Upon the basis of present cost (January 1945) of milling equipment, labor, and building materials, the cost of the suggested mill is estimated to be $80,344. This is based upon the purchase of new equipment and materials and does not include the cost of the plant site, water supply, and tailings-disposal plant. Table 9 is a breakdown of the cost estimate.

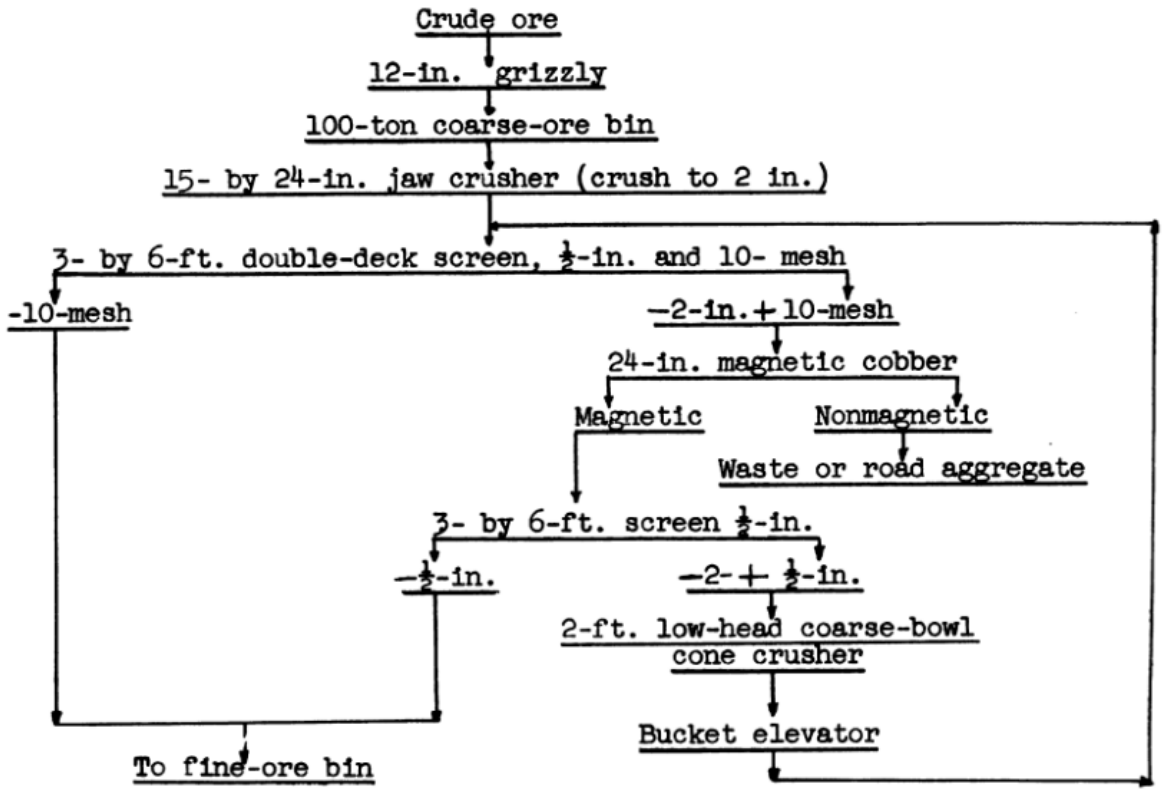


Figure [76]. Suggested flow sheet for 100-ton mill, crushing and cobbing section.

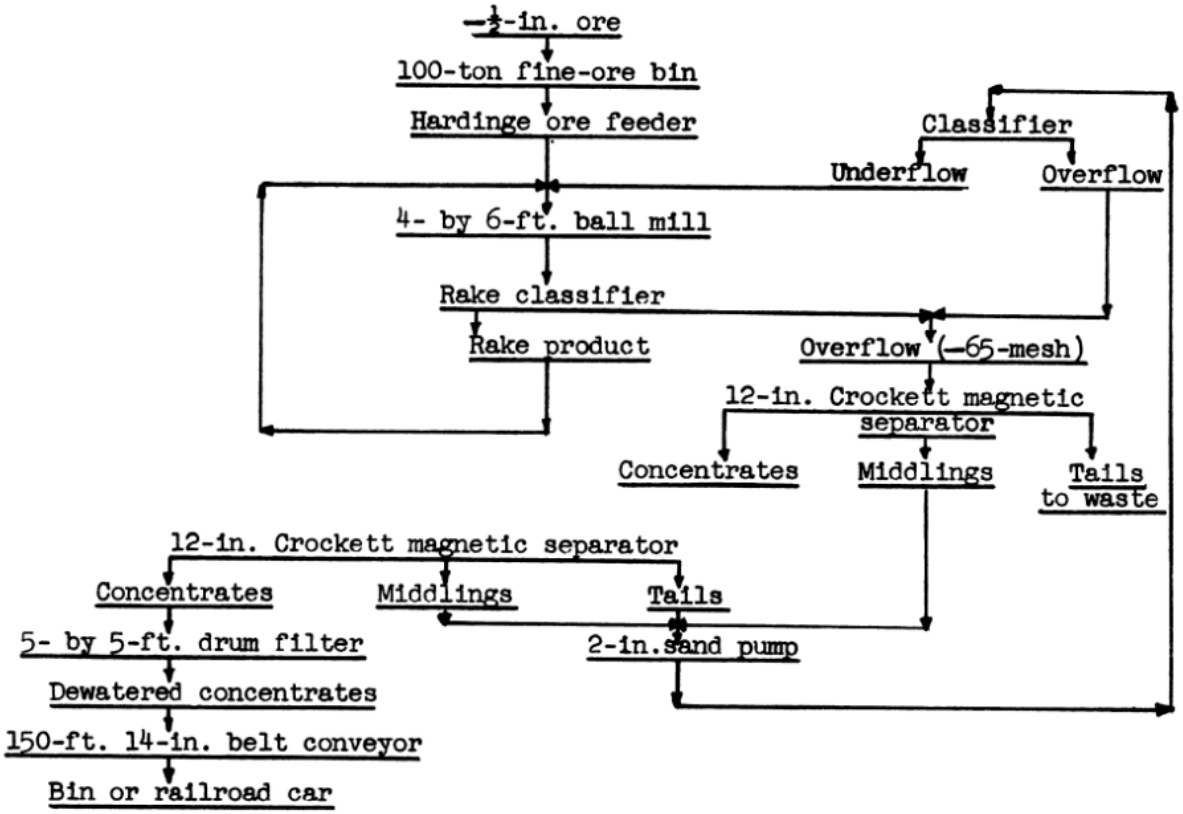


Figure [77]. Suggested flow sheet for 100-ton mill, fine-grinding and concentrator section.

Table 9. - Equipment, Installation, and building coats of suggested mill

Quantity	Equipment	Estimated cost
2	100-ton ore bins	$4,000
1	15” x 24” jaw crusher	5,000
1	3’ x 6’ double-deck vibrating screen	1,120
1	3’ x 6’ single-deck vibrating screen	1,035
1	24” magnetic cobber	1,000
1	2’ coarse bowl low-head cone crusher	4,080
1	Constant weitht ore feeder	680
1	4’ x 6’ ball mill	5,000
1	Classifier	655
2	12” wet magnetic separators	6,918
1	2” discharge sand pump	350
1	5’ x 5’ drum filter	5,000
1	150’ x 14” belt conveyor	1,500
	Total equipment cost	36,338
	Miscellaneous (10 percent equipment cost)	3,634
	Total equipment cost, less freight	40,172
	Installation, buildings, labor, etc.	40,172
	Total cost	80,344

Summary

In March of 1944, construction was begun on a pilot mill for the production of high-grade magnetite concentrates for use in the Bureau of Mines sponge iron pilot plant at Salisbury, N.C. The mill was completed in May 1944 and was operated intermittently until December 1944.

Grinding to 65-mesh or finer was required to liberate the magnetite and gangue minerals, after which concentrates assaying 70.3 percent Fe, O.O35 percent S, 0.002 percent P, and 1.10 percent SiO_2 were obtained by passing the ground ore through two Crockett type-K, wet magnetic separators in series. The recovery of magnetic iron was approximately 94 percent and that of the total iron was approximately 89 percent. The ratio of concentration amounted to 2.65 tons of ore assaying 30 percent total Fe to 1 ton of concentrates.

A flow sheet for a 100-ton mill, estimated to cost $80,344, is suggested. The direct operating cost for such a plant is estimated to be $0.84 per ton of feed, not including mining costs, amortization, taxes, interest, insurance, or freight charges.”[220]

1943 – 1948. Cranberry Magnetite Deposits, Avery County, N.C., and Carter County, Tenn.

“… Development of the deposits was begun in 1943 and continued at intervals until May 1947. During this program, approximately 10 miles of the eastern part of the belt was surveyed by geophysical methods, a number of magnetic anomalies were diamond-drilled, and a pilot plant was constructed for milling tests.

History and Production

A few of the older natives in Cranberry speak of the first iron being made and forged into billets shaped like sled runners. These were then hauled over the mountains by horses, made into tools marked with the name Cranberry, and resold at a premium.

The iron deposits near Cranberry, from which ore was first mined for the used in Catalan forges, were worked at least as early as 1820.

In his fourth report, Dr. Gerard Troost, State geologist of Tennessee in 1837, speaks of the Cranberry iron deposit as follows:

I must mention one situated near the limit which separates the State of Tennessee from North Carolina, at the foot of the Roan Mountain, in Carter County. It seems to be an extensive vein of rich magnetic iron ore, similar to that of some parts of Sweden, and is accompanied with the same minerals as the Swedish ore, namely, a variety of pyroxene (salite or malacolite).

The early literature contains many references to the iron ores of North Carolina but does not contribute materially to the description of the Cranberry area. The first systematic account of the North Carolina ores was given by Kerr.[4] The Cranberry ore bank was briefly described. At that time the mine had not been opened, the ore being obtained from the loose masses scattered through the soil over the vein."

[4] "Kerr, W.C., Report of the Geological Survey of North Carolina: Vol. 1, 1875."

"In 1876, in a report by S.T. Abert to the Chief of Engineers, U.S. Army, attention was called to the construction of a railroad from Johnson City, Tenn., to Cranberry to transport the ore to the furnaces in Tennessee. He estimated that not over 50,000 tons of ore had been mined at Cranberry.[5]"

[5] "Abert, S.T., Examination of Catawba River from South Carolina line to Old Fort, North Carolina: Chief of Engineers, U.S. Army, Rept. For 1876, pt. 1, pp. 367 – 376. appendix G, 1876 [see endnote]."

"In 1876 the mine (Cranberry) came into the possession of its present owners (Cranberry Iron & Coal Co.), and in 1882 it was connected with Johnson City, by rail. In 1884 a small blast furnace was built, and smelting of the ore was begun. Later, in 1900, this, furnace was abandoned, a larger one having been built by the Cranberry Furnace Co. at Johnson City, and since May 1902 the ore has been smelted there. Since 1884 the mine has produced about 1,250,000 tons of merchantable ore, during the 4 years 1917-18-19-20 at the rate of about 60,000 annually. The mine was closed temporarily in January 1921 but was again working in 1923.[6]"

[6] "Abstracted from reference cited in footnote 3."

"The property was operated periodically until 1930. In 1939 the charter of the Cranberry Furnace Co. was changed to the Tennolina Corp.

The furnace at Johnson City and the concentrator plant at Cranberry were dismantled and removed. All rails and machinery have been removed from accessible portions of the mine. A large part of the material was sold for scrap.

S.H. Hamilton, of Johnson City, Tenn., who was geologist for the mine for a number of years, gives the total production from 1882 to 1930 as 1,500,148 tons.[7]"

[7] "Brassert, H.A., & Co., Report on a Magnetic Survey for Iron Ore, Avery County, N.C.: Unpublished rept., 1944."

"The grade of the ore for all the past production of the Cranberry mine is not available. W. S. Bayley states:[8]"

[8] "Reference cited in footnote 3."

"The average of 3 months' shipments during 1920 was: Iron, 38.72 percent and phosphorus, 0.0112 percent. This ore had been hand-cobbed to some extent.

Until October 1919, the ore was cobbed and then concentrated magnetically with the result that much of the ore, too lean to be shipped direct, was made available for use. The mill was closed at the end of October, 1919. During the last four months of its operation, 9,941 tons were shipped.

Bayley says that the Cranberry iron was guaranteed not to exceed 0.035 percent in phosphorus; consequently, the furnace feed could not average more than about 0.02 percent phosphorus…

Description of Deposits
Cranberry Mine
Introduction

The Cranberry iron mine is in Avery County, N. C., at the town of Cranberry on U. S. Highway 19E, 79 miles north of Asheville, N. C., and 29 Miles southeast of Elizabethton, Term.

The mine has produced about 1,500,000 tons of magnetite iron ore during its periods of operation between 1882 and 1930. The property was closed in 1930 and has not been operated since.

Bureau of Mines work at the Cranberry mine consisted of diamond-drilling the deposit for extensions of the ore bodies, mining 1,400 tons of magnetite ore, and constructing a pilot mill for milling the ore. Drilling was begun at the Cranberry mine in November 1943 and completed in August 1944. Mining of the ore, construction of the pilot mill, and mill tests at the mine were started in December 1943 and completed in October 1944.

Ownership

The mineral rights on 1,600 acres and the surface rights on 24 acres, which contain the major mine openings… are owned by the Tennolina Corp., with head offices at 1420 Walnut Street, Philadelphia, Pa. The remaining surface rights were sold to J.A. Taylor of Cranberry. He has sold 274 acres to the Mead Corp. of Sylva, N.C., for the timber and many small tracts to individuals for home sites…

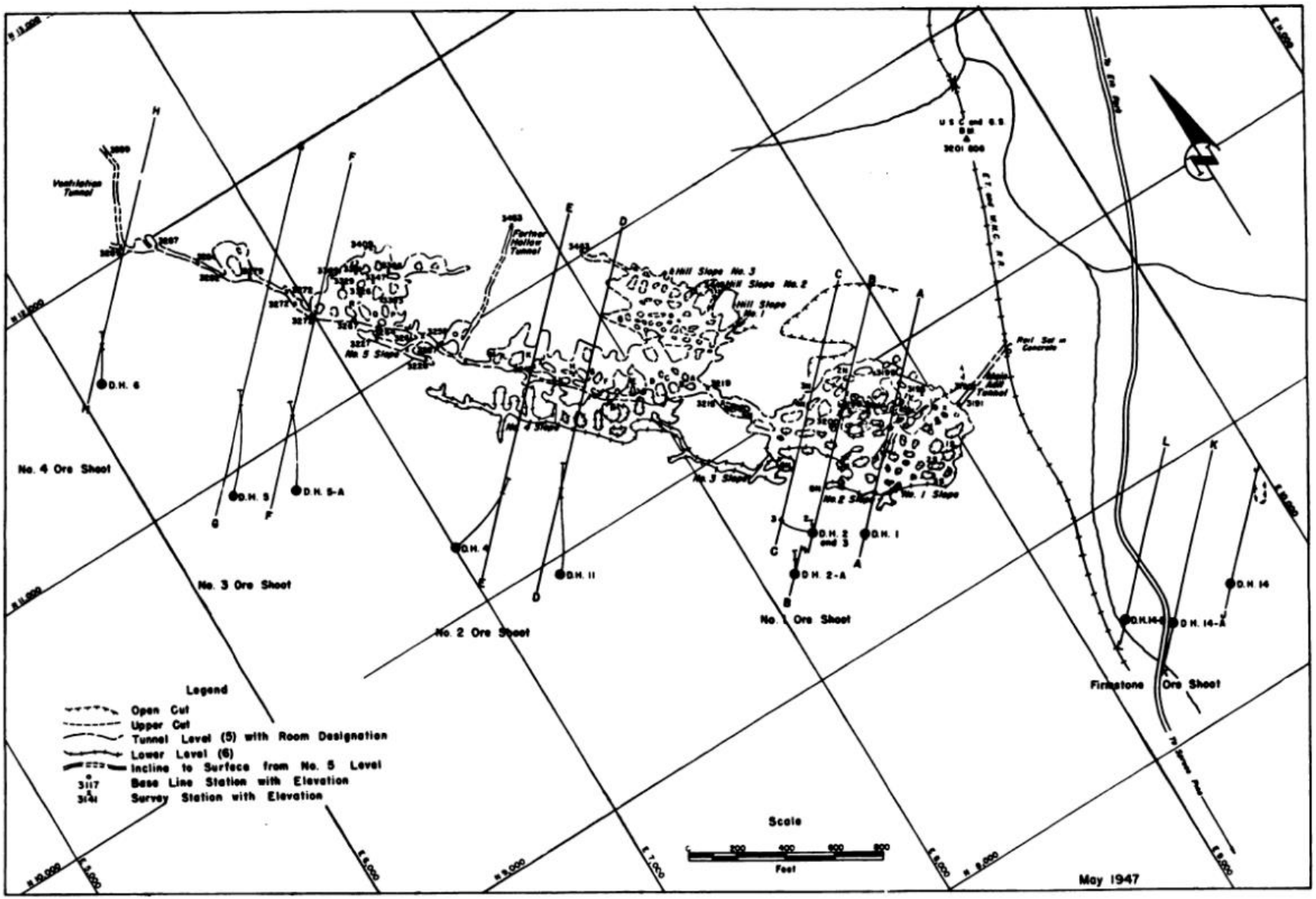


Figure [78]. Plan of underground workings of Cranberry mine.

Exploration of Cranberry Mine

Twelve diamond-drill holes were completed, totaling 9,891.6 feet. Nine holes were located to test the downward extension of ore bodies formerly mined in the principal workings of the Cranberry mine. Four were drilled on the first ore body (fig. [78]). Three of these, holes 1, 2, and 3, drilled to intersect the ore body near the 3,000-foot level, indicated a lens-like cross section thinner than in the mine. The fourth, hole 2-A, drilled to intersect near the 2,900-foot elevation, proved the continuation and swelling of the ore body down the dip.

Two holes were drilled to intersect the second ore body near the 3,000-foot elevation. The first, hole 4, showed magnetite and seemed to have penetrated an edge of the ore body. The second, hole 11, showed much less magnetite than hole 4. It is probable that if hole 11 had been placed on the opposite side of hole 4 and down dip, it would have shown the continuation of the ore body penetrated by hole 4.

Two holes, 5 and 5-A, were drilled to intersect the ore body near the 3,000-foot elevation on the third ore body. Both showed good magnetite and indicated a lenslike cross section.

Hole 6 was drilled to intersect a possible fourth ore body. Good magnetite concentrations were cut close enough together to make a low-grade ore zone 7 feet thick.

Three holes were drilled on the Firmstone ore body south of the Cranberry mine. They indicate an ore body of lenticular cross section, with a rake of approximately S. 70° W.

Mine Workings

The hill slopes and open-cuts were mined from the surface, and the lower parts of the mine were worked from the adit called the 3200 level.

At present the portal of this adit is caved, and entry is made through the open-cut. The grades on the 3200 level are steep, approaching 3 percent in places and averaging near 2.4 percent. The 3200 level was driven along the hanging wall, and from it a mining system was employed using open stopes with pillars. Part of the stopes connected with the open-cut were mined with the hill slopes. Openings below the 3200 level were run down and called slopes. Drifts appear to have been driven along the bottoms of the slopes on what would approximate a 3100 level. All workings below the 3200 level are flooded. Other workings, primarily prospects, exist to the southeast of the mine. They are called the Firmstone (caved), the Smoky No. 1, and the Smoky No. 2.

There is no equipment or plant on the property except that installed by the Bureau of Mines for use in connection with the project…

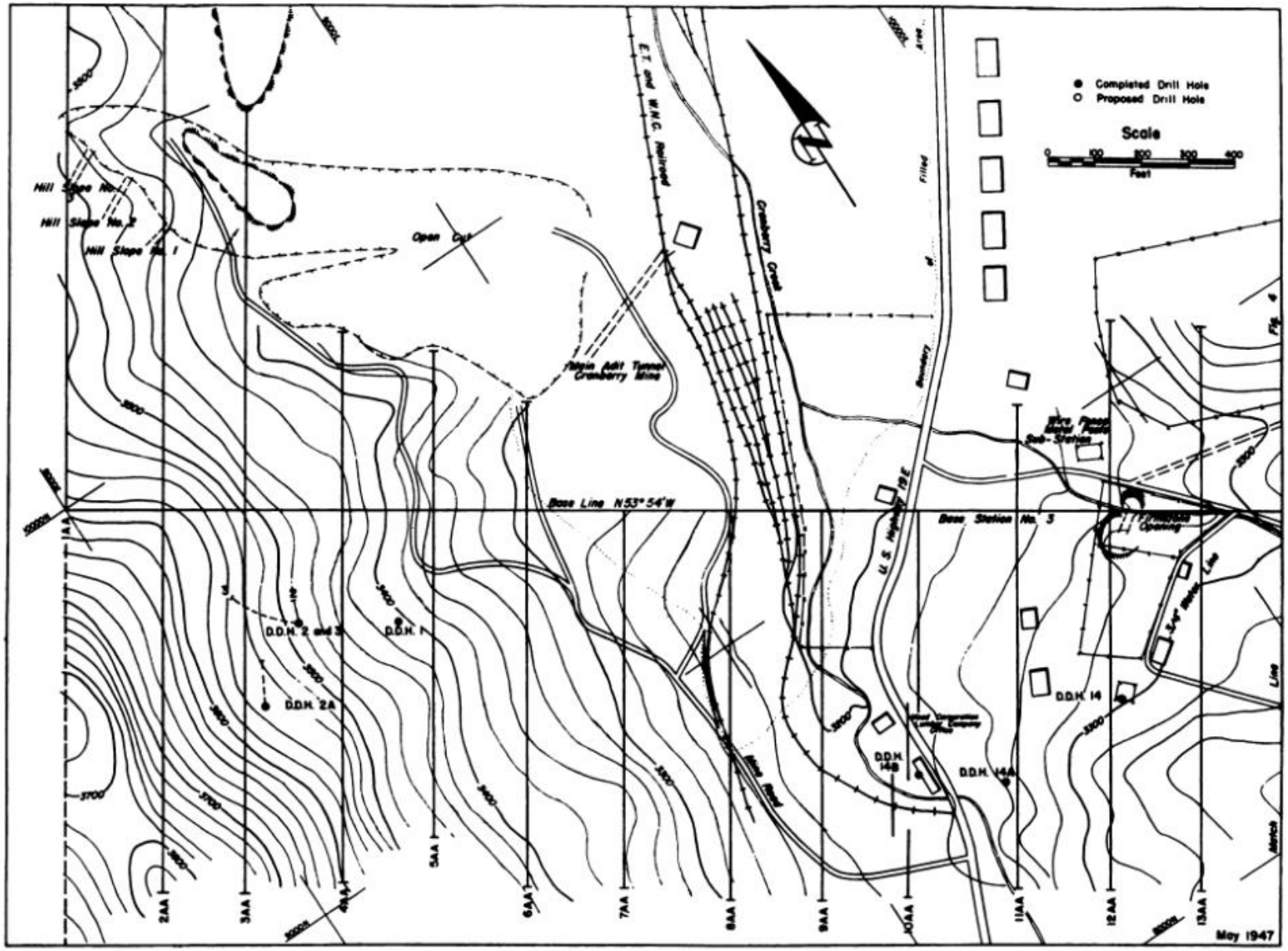


Figure [79]. Topographic map of Cranberry mine area, Avery County, N.C.

Cooper Mine

The first openings on the vein northwest of the Cranberry mine are at the old Cooper place about three-quarters of a mile south of Elk Park. At present nothing can be seen of the mine but several large depressions, which represent the old cuts. Nitze states that the openings were made about 1884 and that a small amount of ore was shipped from them to Roanoke, Va. He says there was exposed a body of ore and mixed ore and gangue, varying in thickness from 5 to 10 feet, which dipped about 33° southwest.

Nitze, H.B.C., Iron Ores of North Carolina: North Carolina Geol. Survey. Bull. 1, 1893.

Magnetic measurements in the vicinity of the Cooper mine…show very little magnetic disturbance. The very small anomalies found here do not verify the reported existence of an ore body 5 to 10 feet thick…

Wilder Mine and Magnetic Anomaly

The Wilder mine is the next, mine workings northwest of the Ellers openings. It is about three-quarters of a mile west of the North Carolina line in Carter County, Tenn.

The Wilder mine was first opened before 1880, but was worked only on a small scale. It was acquired by Milt Miller and associates in 1916 and about 5,000 tons of lean ore was shipped to the Cranberry Furnace Co., at Johnson City. The last shipment (in July 1918) was 10 cars of ore averaging 30.70 percent iron and 0.014 percent phosphorus. The average iron content of 4,915 tons shipped to the Cranberry Furnace was reported by E.B. Kirby to be 37.5 percent and that of titanium oxide 0.15 percent.

The mine consists of several large open pits, several tunnels and underground drifts, and a number of smaller openings distributed in a confusing manner due to the fact the vein is folded.

The vein matter is very much like that at Cranberry. The major part consists of layers of interbedded hornblende and epidote alternating with layers of coarse hornblende. The epidote grades into pegmatite which clearly is intrusive into the hornblende, forming an impregnation gneiss.

Bayley, W.S., The Magnetic Iron Ores of East Tennessee and Western North Carolina: Tennessee Div. Geol., Bull. 29, 1923, p. 119…

Teegarden and Ellis Mines and Anomalies

The Teegarden and Ellis mines are about three-quarters of a mile southeast of Shell Creek Station on the road up Shell Creek… The eastern mine, in Vance Hollow, is known as the Teegarden or Shell Creek mine, and the western one, in Ellis Hollow, the Ellis mine or Cakes Entry.

The mines were worked by Messrs. Ellis and Kirkpatrick in 1917, producing about 500 tons of ore that was taken by the Cranberry furnace. In December 1917, the Cranberry Furnace Co. leased the property and operated the Teegarden mine until the end of May 1919. The Ellis mine was worked mainly as a prospect.

During the two years of operation there were shipped from the property 17,375 tons of ore, averaging 36.36 percent iron and 0.0113 percent phosphorus. It was fed to the furnace

without beneficiation. As mining progressed, the quality of the ore deteriorated to such an extent that it was no longer acceptable at the furnace and shipments were stopped. Between May and September 1917, the average content of the ore shipped was 43.63 percent iron and 0.0093 percent phosphorus, and between January and May 1919, the average iron content was 32.10 percent and the average phosphorus 0.014 percent…

Peg Leg Mine

The openings of the Peg Leg mine are situated on the divide between Hampton Creek and Doe River. The Peg Leg mine has been worked intermittently since colonial days, and as late as 1885 ore was taken from the surface to supply the Doe River forge on the banks of the Doe River. The Crab Orchard Iron Co. reopened the mine in 1898 and shipped about 1,000 tons of ore. The mine was again closed and remained idle until 1917, when it was prospected by the Magnetic Iron & Coal Co. During this last operation, a cut was driven 600 feet in an easterly direction through a vein 50 feet wide, of which about a third was lean ore.

E.B. Kirby states that the east cut of the Peg Leg mine shows ore averaging 33.8 percent iron through a distance of 150 feet along the vein and that it may be broken in faces 10 to 17 feet wide.

At the opening made in 1917, which is about 1 mile south of Roan Mountain station on the road up Doe River, is a large dump of fresh rock on which nearly all the varieties of rock seen at Cranberry may be recognized. The ore fragments show a very rich, coarse magnetite like that of the later ore at Cranberry.

Old Forge Mine

The Old Forge openings are about 500 feet from the west bank of the Doe River and nearly opposite the Peg Leg mine. Hamilton states that old pits and float ore are so distributed as to indicate a vein about 100 feet wide. E.B. Kirby says that on the west side of the river the ore appears in two streaks 5 and 6½ feet wide. In the first streak the total iron content was 39.98 percent and the quantity of magnetite 28.86 percent, while in the second the total iron was 21.3 percent and magnetite 7.73. Sixteen hundred feet beyond this are exposures of 36-percent ore in a. face 16 feet wide; and on the crest of a hill 1,300 feet farther west, a 7½-foot vein was disclosed in a shallow pit. Kirby believed the ore bodies to be a series of lenses along the strike and dip.

Abstracted from Bayley, W.S., The Magnetic Iron Ores of East Tennessee and Western North Carolina: Tennessee Div. Geology, Bull. 29, 1923…

Pilot-Mill Tests of Cranberry Ore

General

The ore for the mill test was obtained from the Cranberry mine. The available ore in the mine was located almost half a mile from the portal and it was necessary to use trucks for haulage. Fourteen hundred tons of ore was removed and hauled to the pilot mill for testing. About two-thirds of this ore was cobbed from lean ore broken and left in the stopes during the operation of the mine, and the balance was blasted from the stope faces.

Thirteen hundred and sixty-five tons were milled and 301.2 tons of concentrates produced averaging 70.3 percent iron.

Abstracted from Lamb, Frank P., and Woodard, D.A., Pilot-Plant Production of High-Grade Magnetite Concentrates, Cranberry, N. C: Bureau of Mines Rept. of Investigations 3980, 1946, 7 pp…

Description of Pilot Mill:

The primary objective in mill design was the simplest possible construction that would produce a magnetite concentrate of at least 7.0 percent soluble iron content, in large enough quantity to satisfy the requirements of the Bureau of Mines sponge-iron plant at Salisbury, N.C.

Owing to manufacturing difficulties during the war, two 12-inch, commercial, type 'K', Crockett magnetic separators intended for use in this operation were not delivered until several months after the rest of the milling equipment was ready to operate. Consequently, during the majority of the mill run a 6-inch laboratory Crockett magnetic separator and a No. 6 Wilfley table, which were available at the Bureau of Mines College Park Experiment Station, were used to concentrate the ore. The capacity of these machines was small, and continuous operation was impossible owing to the necessity of passing the concentrates back through separators two or three times to make a product of the desired grade.

However, after the 12-inch Crockett magnetic separators were installed, the operation was satisfactory, and the milling costs were maintained at a level commensurate with most pilot-plant operations. The mill, when completed, had a capacity of 40 tons of ore per day and produced a concentrate containing a minimum of 70 percent soluble iron. The recovery of magnetic iron averaged approximately 91 percent. The pilot mill flow sheet is shown in figure 32.

The mine-run ore was crushed to approximately l¼ inches maximum size and was then reduced to 95 percent through 80-mesh with a 4- by 6-foot Allis-Chalmers ball mill in closed circuit with a Dorr single-rake classifier.

The classifier overflow went directly to a 12-inch Crockett type 'K' magnetic separator; the concentrate from this machine was re-treated in a second separator of the same type; the middlings from both machines were returned to the grinding circuit; and' the tailings from each machine were discarded…"[221]

Figure 78. Cranberry, 1952, by Chris Ford,
The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co.[222]


Elk
Park
Cranberry
Wye
ET&WNC
Mainline
Station
Shelter
Time
Square
Diner
Site of
Cranberry
Inn
Cranberry
Creek
Hwy
19E
Hwy
19E
Possible
Site of
Original
Furnace
Cranberry
School

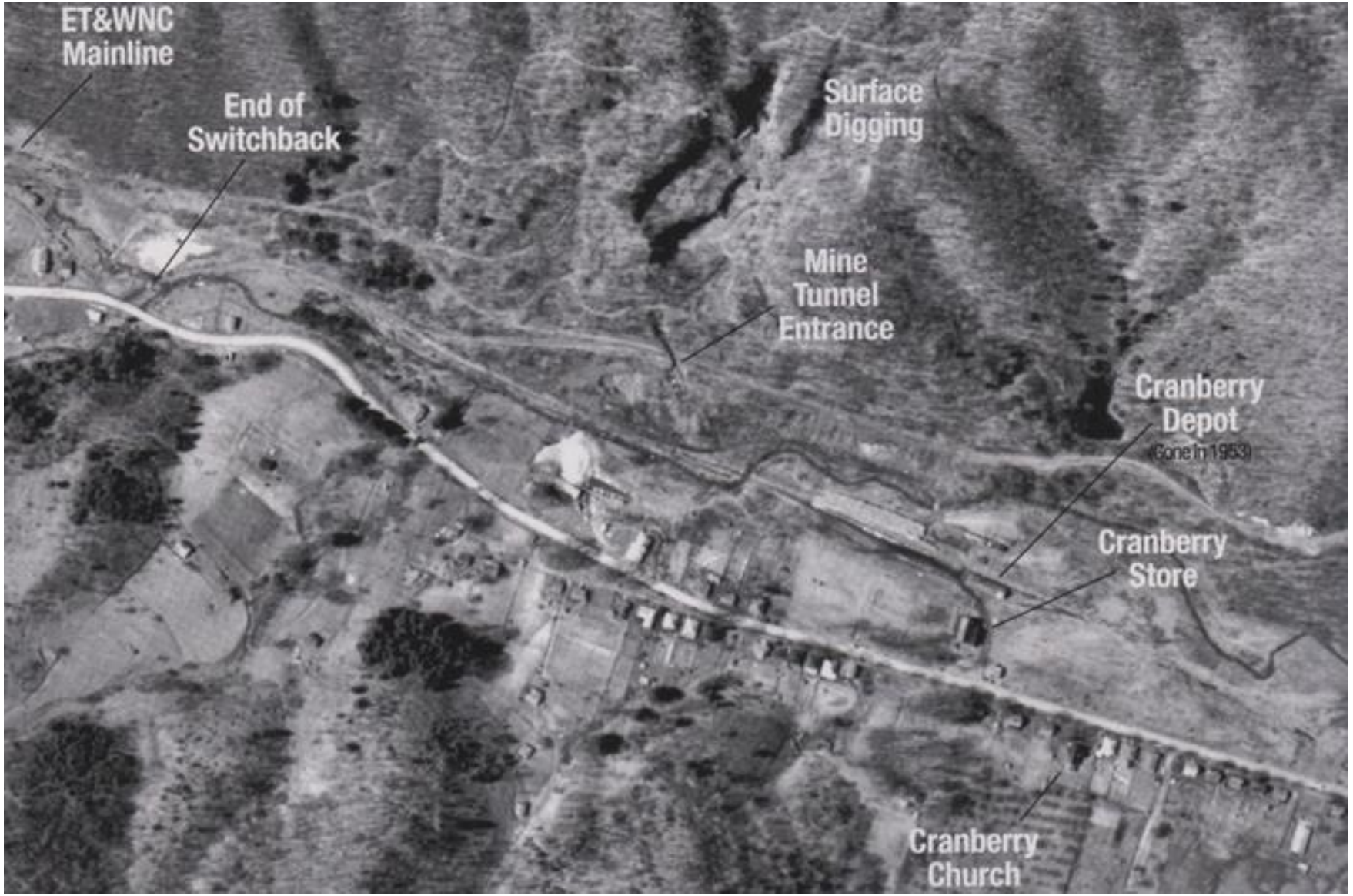


Figure 78a. Detail from above, by Chris Ford,
The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co.[223]

Late 1950s – early 1960s. "Cranberry, North Carolina," by John R. Waite.

"In the late 1950s, Greenback Industries out of Greenback, Tennessee, reopened the mine. It was not a large operation, but it did provide a handful of jobs for some of the young men in the area.

Greenback constructed several new buildings, on the site of the old mine complex, to house the operation. Ore was trucked out of the mine to hoppers made from old Clinchfield hopper cars and set into the hillside above the old railroad right-of-way. The ore then moved through three roller/crushers that pulverized the large ore, in steps, down to a very fine size. It was then magnetically concentrated by a series of magnetic rollers.

The concentrated iron ore was trucked out of the mountains. It was sold by Greenback for use in automobile in-windshield radio antennas, as ballast on nuclear submarines, and for dust control in coal mines.

Greenback's operation only lasted into the early l960s. After they shut down, another operator used Greenback's old equipment to load sand, trucked in from near Bakersville, into sacks. Eventually, that operation closed. The buildings constructed by Greenback were finally rom down and hauled away for scrap by Elizabethton Herb and Metal in 1997."[224]

Appendices

Appendix A. References to the Early History of Iron Meeting Around Cranberry

"Forge Bounty Land Grants. One of the first needs of these pioneers was iron, and in 1788 (Ch. 293, Laws of N.C. as revised by Potter J.L. Taylor and Bart Yancey, Esqs., 1821) the legislature passed an act by which 3,000 acres of vacant lands 'not fit for cultivation most convenient to the different seats is hereby granted for every set of iron works, as a bounty from this State to any person or persons who will build and carry on the same.' One or more tracts for each set of works was to be entered and a copy of the entry transmitted to the next court that should be held in the county, when a jury of twelve persons of good character should view the land and certify that it was not fit for cultivation. Iron works were then to be erected within three years, and when it should be made to appear to the court that 5,000 weight of iron had been made the grant was to be issued. 'Three forges where it was made grew up in Buncombe county, one on Hominy creek, upon the old Solomon Luther place, which belonged to Charles Lane; another on Reems creek at the Coleman mill place, which belonged to the same man, but was sold by him in 1803, to Andrew Baird; the third was on Mills river, now in Henderson county on what has ever since been called the Forge mountain, on which are also the Boilston gold mines. The iron ore for this purpose was procured at different places in Buncombe county.'[20] The State granted to Thomas Calloway, November 21, 1807, 3,000 acres of land in Ashe county (Deed Book D, p. 88) and to William Daniel, David Worth, Moses L. Michael and R. Murchison 2,000 acres in Ashe county, in 1854. (Deed Book U, p. 62.) Grants were also issued to the late Messer Fain in Cherokee, and some of the pigs are still in existence there."

[20] "Ashville's Centenary."

"Dates of Working Old Iron Mines. From 'The Iron Manufacturer's Guide' (1859, by J.P. Lesley) we find that Harbard's Bloomery Forge near the mouth of Helton creek was built in 1807 and washed away in 1817; that the Cranberry Bloomery Forge on Cranberry was built in 1820, and rebuilt in 1856; that North Fork Bloomery Forge eight miles northwest of Jefferson on New river, was built in 1825; abandoned in 1829; washed away in 1840; Ballou's Bloomery Forge, at Falls of North Fork of New river, 12 miles northeast of Jefferson, was built in 1817; washed away in 1832 by an ice freshet; Helton Bloomery Forge, on Helton creek, 12 miles north-northwest of Jefferson, was built in 1829; washed away in 1858; another forge was built one and one-fourth miles further down in 1802, but did not stand long; Laurel Bloomery Forge, on Laurel creek, 15 miles west of Jefferson, built in 1847; abandoned in 1853; Toe river Bloomery Forge, five miles south of Cranberry Forge, built in 1843; Johnson's Bloomery Forge, six miles south of Cranberry Forge, built in 1841; Lovingood Bloomery Forge, on Hanging Dog, Cherokee county, two miles above Fain's Forge, built from 1845 to 1853; Lower Hanging Dog Bloomery Forge, five miles northwest of Murphy, built in 1840; Killian Bloomery Forge onehalf miles below Lower Hanging Dog Forge, built in 1843, abandoned 1849; Fain Bloomery Forge, on Owl creek, two miles below Lovingood Forge, built in 1854; Persimmon creek Bloomery Forge, on Persimmon creek 12 miles southwest of Murphy, built in 1848; Shoal creek Bloomery Forge, on Shoal creek, five miles west of Persimmon creek Forge, built about 1854; Palsey Forge, built by John Ballou at mouth of Helton in 1859 and rebuilt by W. J. Pasley in 1871 (it is now abandoned); New River Forge on South Fork of New river, one-half mile above its junction with North Fork; built 1871, washed away in 1878. Uriah Ballou of Crumpler, N.C., has gold medals for the best magnetic iron ore from the Louisiana Purchase Exposition and from the World's Fair

at Paris immediately afterwards, which was taken from these mines. The lands are now the property of the Virginia Iron & Coke Company.

Pioneer Thors And Forges. Iron was manufactured at these old time forges about as follows: When the ore was in lumps or mixed with rock and dirt it was crushed by 'stompere,' consisting of hardwood beams 6x6 inches, which were raised and dropped by a cogged horizontal revolving shaft. When the ore was fine enough it was washed in troughs to separate it from as much foreign matter as possible. It was then ready for the furnace, which consisted of a rock base 6x6 feet and two and one-half feet high. On three sides of this base walls of rock were erected two and one-half feet high, leaving one side open. A nest was left in the bottom of this base or hearth, through the middle of which a two inch blast pipe ran, and projecting above it. Air was furnished to this pipe by a stream of water passing through wooden tubes 12x12 inches. A small fire of chips was started in this nest above the mouth of the blast pipe. Over this fire three or four bushels of charcoal was placed and blown into a white heat. Upon this charcoal a layer of ore was spread, and as it was heated, another layer of charcoal was placed above, and on it still another layer of ore. This was gradually melted, the molten ore settling into the nest and the silica remaining on top. Into the mass of melted iron an iron bar would be thrust. This bar was used simply to form a handle for the turning of the ore that adhered to it after it had been withdrawn and placed on the anvil to be hammered. The melted ore thus drawn out was called a 'loop.'

The hammer and the anvil were about the same weight, 750 pounds each, with an eye through, 6x12 inches. They were interchangeable. The anvil was placed on white-oak beams, about the size of a railroad cross-tie, which spanned a pit dug in the ground in order to give spring to the blow made by the hammer. Through the eye of the hammer a beam of strong wood was fastened, the other end working on a pivot or hinge. Near this hinged end was a revolving shaft shod with four large iron cogs, each about six inches long and five niches square, and each having a rounded corner. These cogs lifted the hammer handle rapidly, while above the handle a wooden 'bray' overcame the upward thrust, and gravity drove the hammer downward upon the heated mass awaiting it on the anvil. The blows thus dealt were rapid and heavy and could be heard under favorable conditions ten or more miles.

Silent Finger Signals. It was the duty of the 'tender,' the chief assistant of the hammerman, to withdraw the loop from the furnace and place it on the anvil, when the hammerman took the end of the handle and signaled with his fingers laid on the handle to the tender to begin hammering, which was done by the latter allowing the water to strike the wheel which worked the hammer shaft. Two fingers indicated more rapid hammering, three still more rapid hammering, and the withdrawal of all fingers meant that the hammering should cease. When the foreign matter had been hammered out of the loop, it was divided into two or more loops of 25 to 30 pounds each; a short iron bar, to serve as handles, was welded to each piece, and they were again placed in the furnace and re-heated and then hammered into bars from 9 to 12 feet in length, or divided into smaller pieces for wagon-tires, hoebars, axe-bars, plough-shares, plough-molds, harrow-teeth bars, horse-shoe irons, and gun 'skelps.' There was an extra charge for 'bandage' in the case of wagon-tires, because they were hammered out thinner. In finishing up each bar or smaller piece of iron the tender would pour cold water on its surface to give it a hard and smooth finish.

Giant 'hammermen.' The hammerman soon became a veritable giant in his arms, and it is related of one of the older Duggers that he could insert an arm into the eye of the hammer and another into that of the anvil and strike the two together. For miles below the water powers

which drove these forges the streams were muddy with the washings from the ore. For years iron thus made was the principal commodity of trade. The ends of the iron bars were bent like the runners of a sled, and as many of these bars were bound together by iron bands as could be dragged over the rough trails by a single ox. In this crude fashion many tons of iron found a market on farms remote from wagon roads.

Expensive Hauling. It took from three weeks to a month to go from Asheville to Charleston or Augusta by wagon before the Civil War. The roads were bad, and those in charge of the wagons camped on the roadside, cooking their own meals. No wonder freight rates were high, and that people did without much that seems indispensible now. It is said that Waugh, Murchison & Poe, early merchants of Jefferson, hauled their goods from Wilmington, N.C. The late Albert T. Summey says that: 'goods were hauled from Augusta and Charleston and cost from $1.75 to $2.00 per hundred. Salt cost in Augusta $1.25 for a sack of 200 lbs. Add $4.00 for hauling, and it is easy to understand why people thought it cheap when they could buy it for $5.00.' As late as the spring of 1850 it took Deacon William Skiles of Valle Cruces three weeks to ride horseback from Plymouth, N.C. to Watauga.[21]"

[21] "From 'A Life of Deacon William west Skiles.'"[225]

"I must mention one situated near the limit which separates the State of Tennessee from North Carolina, at the foot of the Roan mountain, in Carter county. – It seems to be an extensive vein of rich magnetic iron ore, similar to that of some parts of Sweden, and is accompanied with the same minerals as the Swedish ore, namely, a variety of pyroxene (salite or malacolite.) This vein is but slightly penetrated, so that neither its extent nor its proper direction is yet ascertained, but there seems to be no doubt that it is extensive… The iron ore known by the name of cranberry ore, in Carter county, is embedded in pyroxene salit, while the same ore at other places has quartz for a matrix."[226]

"Cranberry Ore Bank. 'The Cranberry Ore Bank in Mitchell (now Avery) is pronounced by Professor Kerr 'one of the most remarkable iron deposits in America.' Its location is on the western slope of Iron mountain, in the northwest part of the county, about three miles from the Tennessee line. It takes the name Cranberry from the creek which flows near the outcrop at the foot of the mountain. The surrounding and associated rocks are gneisses and gneissoids, hornblende, slate and syenite. The ore is a pure, massive and coarse granular magnetite. The steep slope of the mountain and ridges, which the bed occupies, are covered with blocks of ore, some weighing hundreds of pounds, and at places bare, vertical walls of massive ore, 10 to 15 feet thick, are exposed, and over several acres the solid ore is found everywhere near the surface. The length of the outcrop is 1,500 feet, and the width 200 to 800 feet' (State Geological Report). It was worked in 1820 by the Dugger family. (See Chapter XVI, 'Notable Cases and Decisions,' section headed 'Carter v. Hoke.')

Cranberry's Antecedents. Dayton Hunter, Esq., a lawyer of Elizabethton, Tenn., owns the land on which stood the first iron works of Tennessee, a deed now in Jonesboro, Tenn., calling in 1778 for Landon Carter's Forge Race. This forge stood about 700 feet east of the present court house of Carter county. This Landon Carter was the father of S.P. Carter, who was both an admiral in the navy and a lieutenant general in the army of the United States. Dayton Hunter

married a daughter of Rev. W.B. Carter, a Presbyterian minister and a noted Greek and Latin scholar. Whether Charles Asher had anything to do with this forge is not known, but on the 18th of December, 1795, he and his wife Molly conveyed to Julius Dugger for seventy pounds, 'current money of Virginia,' (Deed Book A, p. 178), 88¾ acres on the south side of Watauga river, being part of a grant from North Carolina to said Charles Asher; and in May, 1802, John Asher conveyed to the same Dugger 45 additional acres on the same side of the same river (Deed Book C, p. 421). On the 20th of November, 1822, John Asher (a son of Charles and Molly) conveyed to William Dugger (Deed Book C, p. 577) one-fourth of all the land on Watauga river, 'including the Forge,' beginning on a mulberry tree on the north side of the Forge dam, and containing three acres and 54 poles, 'which bargained land and one-fourth of the same, including the iron works, with all appurtenances thereunto belonging, or in anywise appertaining, with free privilege of roads for the use of said iron works, together with the building or repairing timber for the use of said Forge, and free course for water to said Iron Works,' is the first reference on the records to the old Dugger Forge, four miles above Butler, Tenn., on the north side of Watauga river. This would also indicate, what tradition preserves, that Asher was the original iron master, and that he took the Duggers in with him. Joshua Perkins, who is said to have built the Cranberry forge for the Duggers, was a son of Jacob Perkins to whom on the 18th of September, 1811, Richard White, of Washington county, Va., conveyed, for $1,500, 250 acres on the north side of Watauga river opposite the mouth of Elk creek, reserving to himself a right of way over the land conveyed, 'up the hollow,' in order to avoid the jutting rock-cliff which formerly blocked the passage of the road on the right bank. This is the time that Richard White left for Missouri, according to the tradition of that locality. So it would seem that Landon Carter was the forefather of Cranberry Forge, that he was succeeded by Charles and John Asher, and the Duggers, while Joshua Perkins was the real builder of Cranberry Forge in 1820."[227]

"293. Cranberry Bloomary Forge, No. 1, situated on Cranberry creek, twelve miles east of Jefferson, Ashe county North Carolina, was built about 1832 and washed away in 1845.

294. Cranberry Bloomary Forge, No. 2, situated fourteen miles south of Taylor's store, on Cranberry creek, owned by Twitty, Miller, Bymun and others, leased and managed by J.C. Harden, Watauga county, built in 1820, rebuilt in 1856, has 2 bloomary fires and 1 hammer driven by water, and made in 1857 about 17 tons of bars.

295. Toe River Bloomary Forge, situated five miles south of Cranberry No. 2, in Watauga county, owned and managed by William Buchanan, Yellow Mountain P.O. Yancey county, built about 1843, has 2 bloomary fires and 1 hammer driven by water, and made in 1856 about 4 tons of bars from magnetic ore of superior quality.

296. Johnson's Bloomary Forge, situated six miles south of Cranberry No. 1, owned and managed by Abraham Johnson, Cranberry P.O. Watauga county North Carolina, built in 1841, has 2 bloomary fires and 1 hammer driven by water, and made in 1856 about 1½ tons of bars."[228]

"History of the Cranberry 'Ore Bank,'" The Bulletin of the American Iron and Steel Association.

"R. Talcott Williams, of the Philadelphia Press, who has recently been spending a well-deserved vacation in Western North Carolina, has kindly forwarded to us a letter which he has received from Mr. S.M. Dugger, of Banner's Elk, Watauga county, North Carolina, giving a

history of the development of the celebrated Cranberry iron-ore deposits of that State. We take pleasure in printing the following extracts from Mr. Dugger's letter:

Prior to 1796, and probably about 1790, 'o1d' Reuben White entered 70 acres of government land, including Cranberry 'ore bank.' White transferred his grant to three brothers, Joshua, Joseph, and Jacob Perkins. About 1825 these brothers erected the first forge and made the first iron at Cranberry. Almost the entire machinery was made of wood, and, there being no saw mill within many miles, the dam was planked with hewn slabs. In pursuance of a statute of North Carolina the State donated to the Perkinses for building this forge 3,000 acres of adjoining lands, which they were allowed to locate. About 1833 Abram N. and William Dugger, the latter the uncle of the former, purchased the property from the Perkins brothers. They made a considerable quantity of iron, which they hauled to distant towns in North Carolina and Tennessee. In those days persons often looped the ends of the bars of iron, and putting a chain through the looped ends hitched a horse or an ox to the chain and dragged a number of the bars across the mountains. Abram N. Dugger died in 1849. About 1845 or 1847 General Dunn and his son-in-law Bard, of Pennsylvania, bought the property from the Duggers. The new owners operated the forge about a year and then failed. They went away in debt, owing, among others, the father of the writer, G.W. Dugger, $50. The property next passed into the hands of Robert Twitty, of Rutherfordton, North Carolina, and others of other places, among them John Hardin. The next transfer was to a Mr. Russell, of Philadelphia, I think, General Hoak, of Raleigh, North Carolina, and others, and thence to the present company. Some of the above names, especially Dunn, Bard, and Twitty, are spelled according to their pronunciation, but I can not vouch for their orthography. Neither am I certain about the dates, which I have only approximated."[229]

Appendix B.
"Brown et al. v. Cranberry Iron & Coal Co.
(Circuit Court of Appeals, Fourth Circuit. February 5, 1895.)
No. 87."

"Writ of Error—To what Judgment Lies.

B. brought a suit in equity against the C. Co. for partition of certain lands. The C. Co. answered, denying B.'s title, and the court stayed proceedings in the partition suit, and gave leave to plaintiff to bring an action at law, which he did, in the ordinary form for the recovery of land, the C. Co. setting up in defense that B. was estopped to claim the land both by deed and by acts in pais. Upon the trial, before the same judge by whom the partition suit had been stayed, the question of estoppel by deed was reserved from the jury, and, in submitting the question of estoppel in pais, the judge stated that he could, as chancellor, have heard the evidence, and decided the whole controversy himself, but preferred to get the assistance of the jury. The jury found for the defendant, and judgment was entered upon the finding, to which exception was taken, and a writ of error allowed. The judge afterwards passed upon the issue of estoppel by deed in favor of the defendant, but no judgment was entered on that issue. Held, that the proceedings were anomalous. but, treating them as an action at law, the judgment upon which the writ of error was allowed was not final, since a decision upon both issues, of estoppel by deed and estoppel in pais, was necessary to a final decision of the action; and, if exception were taken to a judgment upon the former issue, as decided by the judge, the judgment upon the present writ would not end the case, and that, accordingly, such writ could not be entertained. Morris, District Judge, dissenting.

In Error to the Circuit Court of the United States for the Western District of North Carolina.

This was an action at law by J. Evans Brown and William B. Carter against the Cranberry Iron & Coal Company to recover an undivided interest in certain lands, brought pursuant to leave given in a partition suit, between the same parties. One issue was decided by the court without a jury. 59 Fed. 434. Upon another issue, judgment was entered, on the verdict of a jury, in favor of defendant. Plaintiffs bring error.

This case is somewhat peculiar in its character. Certain persons, Hoke, Sumner, and Hutchinson, had become the owners of a tract of land in North Carolina, known as the 'Cranberry Iron Ore Bank.' They offered it for sale in 1866 or 1867 to parties in New York. Before negotiations for the purchase were concluded, it was discovered that J. Evans Brown, one of the parties in this case, and A.C. Avery, as executor of Isaac T. Avery, claimed an interest in the minerals in the land. As the proposed purchasers were buying the land chiefly for the minerals in it, this claim induced them to break off negotiations. Thereupon Hoke, Sumner, and Hutchinson opened negotiations with Brown and Avery looking to the extinguishment of their claim, so that they could renew their negotiations with the persons in New York, and offer to them a perfect title. The claim set up by Brown and Avery was this: That Brown and Avery's testator had owned the minerals in this tract of land as tenants in common; that, by his deed, the testator, Avery, had released to Brown all his interest in the minerals in that part of the tract of land lying to the east of a road or path running through the land in a general direction north and south, so that Brown owned an undivided half of all the minerals in the land on the west of that

road or path, Avery owning the other undivided half, and Brown was sole owner of all the minerals to the east of that road or path. This deed was not on record at the time of the negotiation. There was on record a deed between Brown and Avery, the recital of which contained this information. The negotiations between Hoke and his associates and Brown and Avery, executor, ended in the conveyance by Avery, as executor, of an undivided half Interest in the minerals in this land, and some weeks afterwards in the conveyance by Brown, through his attorneys in fact, of 'the following tract of land, situate and being in the county of Mitchell, in the state of North Carolina; that is, the one-half of the mineral interest in said lands.' Then follows a full description of the lands by metes and bounds. Habendum: 'The one-half of the mines and mineral interests in said lands and the appurtenances thereto belonging' to Sumner and Hoke in fee. The consideration paid to Avery, executor, was $17,000; that to Brown, $22,000. These deeds having been executed, the purchasers, thinking they had a clear, unincumbered title in fee, completed the sale to the parties In New York, and, by mesne conveyance from the latter, the property has been conveyed to the defendant, the Cranberry Iron & Coal Company. This transaction between Brown and Avery, executor, with Hoke and his associates, was in 1867. The coal and iron company, having purchased, went to great expense in developing the mineral resources of the property, erecting buildings, constructing a railroad, and sinking shafts. But they have not actually mined, beyond a test or so, any of the land east of the road or path. They have been in actual use and cultivation of the whole surface. Some time preceding February, 1890 (the record does not state when), J. Evans Brown filed his bill in the circuit court of the United States for the Western district of North Carolina, against the Cranberry Iron & Coal Company, praying partition. He joined with him, as co-complainant, William B. Carter, to whom, some time after his deed to Hoke and his associates, he had conveyed one-half of the interest he now claims. His position is that his deed, by his attorney, conveyed only one-half of the interest in the minerals; that he had owned all the minerals in that part of the land east of the road or path, and that still the other half interest in the minerals on this east side remained in him. His prayer is for partition of this mineral interest,—one-fourth to himself, one-fourth to Carter, and one-half to the Cranberry Company. The answer of the Cranberry Company denied the title of the complainant. The record does not disclose the exact character of this defense. The judge who presided in the circuit court in equity stayed proceedings in the cause, and gave leave to plaintiff to bring and prosecute an action at law within one year, to establish his title as tenant in common to the land of which he prayed partition, the defendant in its answer having asserted sole seisin. Compare Brown v. Coal Co., 40 Fed. 810. The action was brought in the form prescribed by the Code of North Carolina for the recovery of real property. The answer of the defendant interposed, as a first defense, a general denial of the plaintiff's title, and, by way of a second defense, set up certain facts constituting, as was claimed, estoppel in pais and estoppel by deed, thus precluding the plaintiff from claiming title as against the defendant. The cause, being at issue, was tried before a jury and the same judge who had presided in the court of equity. At this trial all other issues seem to have been abandoned, and the only issue presented was that of estoppel, the onus having been cast on the defendant. This aspect thus presented by the case is explained by the learned Judge in his charge to the jury. The suit has been brought, and the only question for you to determine at issue in this court is, is the plaintiff estopped from claiming title by deed, conduct, acts, or otherwise? As chancellor in the court of equity. I could settle the case myself, and I could have heard all the evidence and all the matter myself, but I preferred to get the assistance of the jury on certain questions of fact, and I have called you in for that purpose. The court reserved its opinion upon the question, were the plaintiffs estopped by deed? and

submitted to the jury the other question: 'Are the plaintiffs estopped by their acts, declarations, or otherwise from claiming any interest in the mines and minerals in the land described in the complaint?' They answered this question, 'Yes.' Judgment was entered on this finding. Exceptions having been taken in due course, a writ of error was allowed, and the case is before us on the exceptions and assignments of error. After granting the writ, the judge passed upon the issue of law stated by him at the trial, and reserved by him, and held that the plaintiffs were estopped by the deed. No judgment has yet been entered on this issue. The sole question before us is on the writ of error.

Charles A. Moore, for plaintiffs in error.
Richard H. Battle, for defendant in error.

Before Goff and Simonton, Circuit Judges, and Morris, District Judge.

Simonton, Circuit Judge (after stating the facts). It is not easy to determine what this proceeding at law was. It began an action at law, growing out of a proceeding in equity brought under the direction and with the permission of the chancellor. The complainants claimed to be cotenants in certain mines and minerals with the defendant, and sought partition. The defendant denied their title, and set up sole seisin. This 'was not a mere point of law or fact incidentally in dispute, but a general question of right, determinable as such by a law court, and requiring a decision, according to the course of that court, both of disputed facts and the law applicable thereto.' The proper course, therefore, was to direct an action at law to be brought to determine the title. Adams, Eq. (7th Ed.) 378. And this is the constant practice of courts of equity in suits for partition when the title is in dispute. 3 Pom. Eq. Jur. § 138C, and note 3. But, when the case came before the law court, every other question was eliminated, and the only issue was this of estoppel, in pais as well as by deed,—an issue within the domain of equity jurisprudence, and cognizable by such a court Pom. Eq. Jur. § 802. When this issue was submitted to the jury, it was with the purpose of aiding the chancellor in coming to his conclusion, submitted in his discretion, and not as a matter of right. This he himself distinctly asserted in his charge. It is not excepted to. In this respect the proceeding assumed the form of an issue for a jury. Such an issue is directed when an incidental question of fact is so involved in doubt, by conflicting or insufficient evidence, that the court considering the inefficacy of written evidence is desirous of referring it to the verdict of a jury. Adams, Eq. (7th Ed.) 375. If this be an issue out of chancery, the finding of the jury and the judgment entered thereon are not reversible on bills of exception and writ of error here. The error, if any exist, must be removed, and corrected in the court ordering the issue. Johnson v. Harmon, 94 U.S. 372; Watt v. Starke, 101 U.S. 250; Brockett v. Brockett. 3 How. 691; 2 Daniell, Ch. Prac. (3d Am. Ed.) 1106; Wilson v. Riddle, 123 U.S. 615, 8 Sup. Ct. 255. If, however, it be an action at law, brought under the direction and by leave of the court, then the court of equity does not assume to interfere with the course of proceedings in the court of law, and all errors made at the trial must be corrected in that court or by writ of error to the appellate court. Watt v. Stark, 101 U.S., at page 250; Bootle v. Blundell, 19 Ves. 500; Adams, Eq. (7th Ed.) p. 378; Smith, Ch. Prac. 90. Treating this record as an action at law, reviewed on writ of error, the result of which must be conclusive of the issues presented, the first inquiry is, is it ripe for a hearing in this court? As an action at law, it must be governed by the course of proceeding in a court of law. This case, as presented in the court below, involved two issues,—one determinable by the court alone; the other submitted to the jury. One issue was:

'Did the deed of Brown estop him and his privy from denying the title of defendant?' The other issue was: 'Are the plaintiffs estopped by their acts, declarations, or otherwise from claiming any interest in the mines and minerals in the land described in the complaint?' Each issue was independent of the other. The decision of both was absolutely necessary to a final decision of the action. The jury found the issue of fact in favor of defendant. That issue is here. The judge has ruled upon the other issue also in favor of defendant. That ruling is not here. If it be not excepted to, it ends the action. If exception be taken hereafter, then our conclusions upon this writ of error will not end the case. In other words, it is not here on a final judgment; and cannot in this record be disposed of. Let the case be remanded to the circuit court for such proceedings as may be necessary, each party to pay the costs by them or it incurred in this court.

Morris, District Judge (dissenting). I do not concur in the opinion or judgment of the majority of the court. The disposition we are required to make of this case depends, in the first place, upon whether the case tried below, in which the writ of error was allowed, was an issue out of chancery, or an independent action at law to try title. If it was the former, it is not properly before us, and cannot be until there is a final decree in the chancery case; if the latter, then it is before us on writ of error to the rulings of the court below, and I think we should consider the exceptions and assignments of error. So far as the pleadings in the record disclose, there is nothing to connect this case with any suit in equity. It begins, like any common-law action, with a summons commanding the Cranberry Iron & Coal Company to appear and answer the complaint of J. Evans Brown and William B. Carter. The complaint filed alleges that the plaintiffs are each seised in fee simple of an undivided fourth interest in the mines, minerals, and mineral interests in certain described lands, and that the defendant is wrongfully and unlawfully in possession, and withholds the same from the plaintiffs; and the plaintiffs demand judgment that they be let into possession of the said undivided one-half interest, and for damages and costs. The defendant answered, alleging that it was sole owner of the land described, and of all the mineral interests therein, and it also filed a special plea, in which it alleged that its grantors had obtained from the plaintiff Brown, in 1867, a deed intended to grant all his (the said Brown's) mineral interest in the land in suit under the circumstances set out in the plea, which estopped the plaintiffs from making any claim whatever to said property. A jury was impaneled to try the issue made by the pleadings between the parties, and, after hearing the evidence and receiving the instructions of the court, the following question was submitted to the jury for their verdict: 'Are the plaintiffs estopped by their acts, declarations, or otherwise from claiming any interest in the mines and minerals in the land described in the complaint?' The jury, for their verdict, answered, 'Yes.' Thereupon judgment was entered that the plaintiffs were not the owners of an undivided one-half interest in the mines and minerals in the lands described in the complaint, and that they take nothing by their writ, and that the defendant have judgment for its costs. It was further 'adjudged' that said finding, together with all the evidence and the charge of his honor, be forthwith reported to the court of equity. This is the first reference anywhere in the record to any equity suit, except that some allusion is made to it in the judge's charge. Bills of exceptions were signed by the judge, and a writ of error was allowed as in actions at law. There is nothing in the record to show that the case tried by the jury was an issue out of chancery sent to a court of law to be tried in order to inform the conscience of the chancellor; on the contrary, except from some allusions by the judge in his charge and the order that the findings, evidence, and charge be reported 'to the court of equity,' we should not know there had been any equity case connected with this litigation. From the briefs of counsel, we gather that a suit for partition had been instituted in equity by Brown and Carter against the Cranberry Iron & Coal Company, and that

the defendant corporation in that suit, by its answer, denied that Brown and Carter had any interest in the land; and thereupon, as the briefs state, the court required the complainants to bring an action against the respondent at law to try title. If we are to take these statements from the briefs of counsel on both sides as informing us that there were partition proceedings in an equity court prior to the instituting of the present suit, it would seem that the equity court proceeded properly. If a suit is instituted for partition by a complainant whose right to partition is denied because he is alleged to have no title or interest in the premises as to which partition is prayed, it is the duty of the equity court either to dismiss the bill, or to retain it for a reasonable time to afford the complainant an opportunity of establishing his title at law. The rule is that a party whose title is disputed or is suspicious must establish his title at law before he conies into chancery asking a partition. If he files his bill for partition, the equity court may, in its discretion, retain the bill until he has done that which he ought to have done before he filed it; and it must always be borne in mind that an equity court is not the proper tribunal to try title to land when the legal title is involved, and when no question to be determined is of peculiar equity cognizance. Hipp v. Babin, 19 How. 271; Lewis v. Cocks, 23 Wall. 466. Where the legal title is involved, the equity court does not send issues to be tried by a jury in order to ascertain the truth of disputed facts for its enlightenment, but lets the party who is out of possession bring his action of ejectment, and suspends its own proceedings until the legal title is made clear by the judgment of a court of law. 3 Pom. Eq. Jur. § 1385; 1 Story, Eq. Jur. § 653; 2 White & T. Lead. Cas. Eq. 900; 2 Daniell, Ch. Prac. 1151, note 5: Cox v. Smith, 4 Johns. Ch. 271; Currin v. Spraul, 10 Grat 145; Boone v. Boone, 3 Md. Ch. 497; Obert v. Obert, 10 N.J. Eq. 98; Read v. Huff, 40 N.J. Eq. 233.

As stated in Watt v. Starke, 101 U.S. 250:

'Where a court of chancery suspends proceedings in a cause in order to allow parties to bring an action at law to try the legal title, it does not assume to interfere with the course of proceedings in the court of law, and a motion for a new trial must be made to that court; but, when it directs an issue to be tried at law, a motion must be made to the court of chancery.'

So it is the practice, when issues are sent to a court of law, to enter no judgment on the verdict, but the judge of the law court certifies to the chancellor what the verdict was. 2 Daniell, Ch. Prac. 1119. The chancellor may disregard such a verdict, but a judgment in an ejectment suit establishing title would stand upon a different footing.

In the case now before us, in my opinion we are not at liberty to consider whether there was set up by the defendant's answer in an equity suit a title based upon matters properly cognizable in equity, such as made it proper for the equity court to proceed and adjudicate with regard to it, or as to which the chancellor might properly send issues to be tried by a jury in a law court for his enlightenment as to a question of fact. We do not know from the record what the equity suit was, and have only before us in this record an action at law regularly begun and tried, the verdict of the jury, the judgment of the court entered upon the verdict, and exceptions to the rulings of the court regularly taken during the progress of the trial, and brought here by writ of error. In his charge to the jury the judge began with some introductory remarks with regard to the commencement of the litigation in the equity court. These were mere side remarks which he himself told the jury to disregard, and told them that it was their duty to find the facts according to their own view of the evidence. The remarks of the judge on this subject were not excepted to. The issue submitted to the jury and their verdict were sufficient to support the judgment for defendant, which was entered, and which was conclusive against the plaintiffs' title. If the

verdict could not be supported without a construction of the deed, and the plaintiffs' case required an instruction to the jury as to the effect of the deed, then the verdict was a mistrial, and we should reverse. It seems to me we must either affirm or reverse.

By plaintiffs' twentieth instruction, the court was asked to say that the deed was no estoppel. The court refused this instruction, and gave no instruction covering it. That refusal was excepted to, and, if the jury were left to consider the deed, it was error, unless we are satisfied that the deed was an estoppel of itself. The issue put to the jury was: 'Are the plaintiffs estopped by acts, declarations, or otherwise?' This issue might appear to have been broad enough to include estoppel by the deed, but the judge does not seem to have treated it so. Treating it as an issue of estoppel in pais, the construction of the deed was immaterial, and under that issue, when the jury found that the plaintiffs were estopped, the defendant was entitled to judgment. That judgment, in my opinion, is conclusive against the plaintiffs, unless they can show, under this writ of error, that there was error in some ruling during the trial of that issue. The opinion filed by the judge, after the judgment was entered, was a mere statement of his reasons for refusing the twentieth instruction, or for not granting a new trial, or for some other purpose of his own, and is not before us except as an argument in favor of some ruling he has made during the trial, and before the judgment entered. It is not in the bill of exceptions, and it could not be excepted to. The case was a trial by jury, and only what took place before the jury can be examined. If the case was not properly put before the jury or they were misdirected, we must reverse. What can the judge now do if we send the case back? The term at which the judgment was entered is past. He could not grant a new trial, and he could not now put anything more into the bill of exceptions, and we can never look at anything but what is in the pleadings and the bill of exceptions. The defendant, to succeed, was not obliged to show that the plaintiffs were estopped both by the deed and by their acts and declarations; either one was sufficient. If, irrespective of the construction of the deed, the acts of the plaintiffs estopped them, then the defendant had a right to rely on that estoppel in pais; and, if the jury found for the defendant on that issue, it was entitled to judgment without considering the deed. The judge was of this opinion, and, when the jury found the estoppel, he entered judgment on the verdict. If they had found for the plaintiffs on the question of estoppel, he would probably, as appears from his opinion, have not discharged them, but would have instructed them that the deed was itself an estoppel, and directed a verdict for defendant. The judge says he had reserved that question, and it is plain he thought that the only issue submitted to the jury was the estoppel in pais, and that, when the jury found their verdict on the estoppel in pais, he considered that ended the controversy, and afterwards wrote out his views about the proper meaning of the deed, to show that he was right in refusing the plaintiffs' twentieth instruction.

I think the case is properly before us for examination of all the exceptions taken at the trial, and I am obliged to dissent from the opinion of the majority of the court, holding the judgment is not final, or that the record is incomplete, and that the exceptions and assignments of error are not before us for our examination."[230]

Appendix C.

"Chapter LX. An Act to Incorporate the Cranberry Iron and Coal Company.

Section 1. The General Assembly of North Carolina, do enact, That Robert F. Hoke, Thomas J. Sumner, Charles W. Russell, Moses L. Holmes, William Murdock, Samuel H. Wiley and Matthew O. Beatly, and such other persons as shall be associated with them, their successors and assigns, be and they are hereby created a body politic and corporate, by the name and title of the Cranberry Iron and Coal Company, by which name said corporation and their successors may sue and be sued, plead and be impleaded in any court of this State, and shall have power to make such by-laws and regulations, not inconsistent with the laws of this State, as may be deemed necessary for the government of said company, and which shall be binding on them, and requisite to carry on the business; it shall have perpetual succession and enjoy all the rights and privileges, powers, liberties, immunities and franchises usually pertaining to a corporation.

Sec 2. Be it further enacted, That the capital stock of said company may be divided into such number of shares and of such amount for each share as the stockholders in general meeting may determine: Provided, That the capital stock of said company shall not exceed five millions of dollars, and that said shares be personal property and transferable, and liable to assessment, as the by-laws may determine.

Sec. 3. Be it further enacted, That a general meeting of the stockholders may be held at any time determined by the by-laws, and that to constitute a meeting there must be present in person, or by proxy, a number holding a majority of the stock, each share of which shall be entitled to one vote, and all acts shall require the sanction of a majority of the votes present.

Sec. 4. Be it further enacted, That said company shall have power to purchase, lease or otherwise, mineral lands, and to work the same for the extraction of iron ore, coal or other minerals or products; to manufacture iron and all products of iron or other minerals and transport the same to market.

Sec. 5. That the affairs of said company shall be managed by a board of not less than three nor more than seven directors, who shall all be stockholders, and one of whom shall always be a resident of this State. They shall be elected by ballot within one year from the passage of this act and annually thereafter, at such times and places as the by-laws may prescribe, and hold their office for one year and until their successors are elected. If from any cause said election shall not take place at the time fixed, it shall be lawful to elect the same at any other time, after twenty days' notice being given. Each share of stock shall entitle the holder to one vote, in person or by proxy, and a majority of the directors shall constitute a quorum for the transaction of business. Said directors shall elect one of their number to be president of the board; they shall fill all vacancies occurring in their own body until the next annual election. At any general meeting of the stockholders they may appoint such other officers and agents as they may deem necessary to manage the affairs of the company, remove the same at pleasure, and establish offices at such places as the wants of their business may require, and perform all such other acts which they may find the successful prosecution of their business demands. And this charter shall be organized by any one of the resident corporators giving twenty days' notice to the other corporators to meet in Salisbury, in person or by proxy, within one year from the passage of this act; and a majority of the corporators shall constitute a quorum for the transaction of business.

Sec. 6. That said company shall have the right, power and authority to lay out, build and construct roads, whether rail train, plank or turnpike, for the successful transportation of iron ore, coal, coke, iron, mineral and all products found upon their land, and also to construct such dams

as shall be needful for the supply of water to their mills, manufactories and furnaces, the drainage of their mines, or for any other purpose found necessary; to erect bridges over streams of water whenever necessary, and to connect such with the railroads of any company now incorporated, or which may be hereafter incorporated by the laws of this State, at any point the said company may select for such connection, and such roads shall be open to the use of the public upon the payment of such reasonable tolls and subject to such rules and regulations as said company may establish.

Sec. 7. That where any land or right of way may be required by said company for constructing said roads and drains, and for want of agreement as to the value thereof, or for any other cause the same cannot be purchased of the owners, the same may be taken and the value thereof ascertained as follows, viz: on application by the company to any justice of the peace for the county where the said land or right of way may be situated, it shall be his duty to issue his warrant to the sheriff of said county to summon a jury of five freeholders to meet on the day named in said warrant, not less than ten nor more than twenty days thereafter, and the sheriff, on receipt of said warrant, shall summon the jury and notify the owners of the land of the time and place at which he has summoned the jury to meet, and when met, he shall administer an oath or affirmation to three of them that they will impartially value the land and right of way in question. The proceedings of said jurors, accompanied by a description of the land, shall be returned under their hands and seals by the sheriff to the clerk of the Superior Court, there to remain as a matter of record, and on the payment of said valuation the lands and right of way so valued shall vest in said company: Provided, That the location of same shall not interfere with any graveyard, house lot or garden without the consent of the owners, and that no more land than thirty feet width on either side from the centre of said roads or drains shall be condemned for the purpose aforesaid: And provided further, That if either party shall be dissatisfied with the valuation aforesaid they may appeal to the Superior Court of the county in which the land lies, and whose decision shall be final; but such appeal shall not delay or interrupt the use and possession of said land and right of way by said company.

Sec. 8. That said company shall have power to adopt and use a common seal with such device and inscription as they shall deem proper, and to change, alter and amend the same at pleasure, and certificates of stock and other official acts shall be authenticated by affixing the same.

Sec. 9. Be it further enacted, That this charter shall take effect and be in force from and after its ratification.

Ratified the 28th day of February, 1873."[231]

Appendix D.
"Wm. M. Meredith V. Cranberry Coal and Iron Company.

Issues – Judge's Charge – Contributory Negligence.

1. Though the issues tendered by a defendant eliminated more distinctly the matters controverted in the pleadings than those adopted by the Court, he has no ground of complaint if the instructions to the jury raised every defence available to him under those he tendered.

2. Where the defence to an action for damages resulting from an accident to the plaintiff, an employee of defendant's railway, was a want of care and prudence on the part of the plaintiff and those identified with him, and there was evidence tending to sustain the defence: Held, that a charge, ignoring the plaintiff's negligence, or co-operating agency in the accident, or that of those identified with him, is erroneous.

3. Though the defendant has been negligent, yet, if plaintiff, by reasonable care and prudence, could have averted the accident, he is not entitled to recover.

Civil Action, tried before MacRae, J., at Spring Term, 1887, of the Superior Court of Mitchell County. The facts sufficiently appear in the opinion.

Messrs. G.N. Folk, D. Schenck, J.F. Morphew and W.B. Council, for the plaintiff.

Messrs. Hoke & Hoke and W.H. Malone, for the defendants.

Smith, C.J. The plaintiff, an employee of the defendant company, at per diem wages, while engaged in transporting wood, to be converted into coal, from the forest to the woodyard over a tramway constructed for that purpose, was struck with a stick of wood, protruding from a loaded car, and thrown from the platform on which he was standing, and suffered the injury for which compensation is demanded in the present action. The complaint alleges, that this was brought about by the cording or packing of the wood too near the tramway, and on either side of it, as directed by one Allen Nimson, a manager and middle man, representing the company in the operation of this department of the work, by reason of which proximity, a loose stick, slipping from the load on a passing car, came in contact with that packed, and in its rebound knocked the plaintiff off, and caused the injuries complained of.

The answer denies the charge of negligence, in placing the wood where it was stacked, denies that Nimson was such representative of the company, and insists that the primary and direct cause of the accident, was the negligent packing of the wood on the car and its too rapid running, causing the load to jostle and some of the sticks to slip out of place, to prevent which, the plaintiff imprudently seized one of them; and that in all this packing and transporting, the plaintiff participated with his associate fellow-workmen.

The issues deduced from the conflicting allegations contained in the pleadings and submitted by the Court to the jury, were:

1. Was the plaintiff's injury caused by the negligence of the defendant? To which the response was, Yes.

2. Did the plaintiff contribute to his own injury by negligence on his part? Answer – No.

3. What damage has plaintiff sustained by reason of defendant's negligence? Answer – Five thousand dollars.

The defendant, besides a similar issue as to the amount of damages, in place of the two first, proposed the three following, which were refused:

1. Did the defendant cause the wood to be so negligently packed on the side of the track of the tram road as to make it hazardous for the loaded tram car to pass?

2. Was the plaintiff guilty of negligence, in not using ordinary care and prudence in running the tram car so as to avoid danger?

3. Was the plaintiff a fellow-servant with Allen Nimson?

The facts disclosed in the testimony, heard at the trial, so far as they are necessary to elucidate the matter on which the determination of the defendant's appeal rests, are, in substance, the following:

The wood was cut and brought from the forest, a mile distant from the place of deposit in the yard, on flat cars, each carrying a cord, passing over a tram or railway, on an inclined plane, and descending by force of gravitation, the speed being controlled by breaks on each. At the time of the accident, the train consisted of two loaded cars, upon the rear platform of the foremost of which, the plaintiff was standing. The train was moving with unusual rapidity, and several sticks of the wood on a car were jostled and began to slide, to prevent which, the plaintiff, being called on to do so by one Bass, a fellow-servant, at the lower end of the nearest car, stepped on the adjoining platform of that car, and seized a loose stick, with the intention of replacing it, and in doing so, the stick came in contact with the stacked wood, and the other end struck the plaintiff with great violence and threw him to the ground. While prostrated, he sustained the injury mentioned. The placing and stacking the wood so near the tramway was done by the express order of said Nimson, to whose charge and management the business was confided by the defendant, and his co-laborers in the work of transportation, as was the loading of the cars and accompanying them to the place of unloading, but it does not appear that any instructions were given as to the manner of putting up the wood, or supervision exercised over the work as it progressed.

It was no uncommon thing, as the plaintiff himself testifies, for the wood on the car to be so disturbed by jarring of the car in motion, and if not going too fast, it was not hazardous to arrest it, and retain it in place, in the manner attempted in this case. It was, if the car was going rapidly. A witness for the defendant, John Ellis, who graded the track, and had been connected with the road for 33 years, after describing the declivity of it, and its passing between the stacks on either side of the yard, testified to having cautioned the plaintiff, perhaps as many as twenty times, about running too fast, and told him that some of the men would be killed if they came down so rapidly, and that sometimes, when himself riding on the cars, he would enjoin it on the employees to run slowly.

They were expected to make eight trips a day, and lacked one of completing the number at the hour 3 P. M., on Saturday, when the plaintiff was hurt.

Allen Nimson, examined for the defendant, also testified to his warning repeatedly when riding on the cars, and when passing them in motion cautioned the hands in charge, the plaintiff among them, against fast running, and that the plaintiff had been in this employment from one and a half to two years.

There was a general concurrence of opinion among the witnesses, and especially among those of skill and experience, in the defendant’s service, who were introduced by it, that cars could, when so loaded, be run with safety, if run slowly, and little, if any, hazard would be incurred in restoring slipping pieces to their proper place by hand; but it would be otherwise, if the cars were moving at a rapid rate. Whether the cars were moving at an increased speed on this occasion, the evidence was somewhat in conflict, but none that they moved slowly.

There was much testimony as to the powers conferred upon Nimson, and exercised by him for, and in place of, the company, and whether the legal effect was to lift him above the sphere of co-servant, to the place of their common principal, in his relation to them, which we do not reproduce, as our decision of the case rests upon other grounds.

The issues tendered for the defendant eliminate more distinctly, in our opinion, the subject-matter of controversy presented in the pleadings, than do those adopted by the Court; but the instructions to the jury, upon them, raised every defence available to the defendant under the others. Its responsibility was made to depend upon actual negligence of its own, the distinction pointed out when it proceeds from a fellow-servant, and when it proceeds from one who, as a middle man, assumes the relation of his principal towards subordinate employees, the absence of contributory negligence on the part of the plaintiff, all which enter into the question of the defendant's liability for damages.

But we do not think that the concurring agency of the plaintiff, as involving a want of care and prudence on his part, was, upon the evidence, with sufficient distinctness presented to the jury.

The culpability imputed to the company was not in the insecure manner of packing the wood, nor did the injury arise from a want of care in this particular, for the wood remained steadfast in its place; but, in causing it to be packed in such close proximity to that on the passing car. Even in this packing the plaintiff himself took part. The accident was directly brought about by what took place on the car, and the question of the want of due care in those managing it, in avoidance, was not clearly presented in the charge, as a contingency upon which the company's responsibility depended.

A portion of the charge, to which exception was taken, is in these words: ‘It is not now contended, that the wood was so placed as to strike the car, or the plaintiff upon the car, in the discharge of his duties. It is said to have been caused by a stick falling and striking the wood rack and rebounding against the plaintiff. In order to make the injury the result of the negligence of the defendant, it must have been produced by this negligence concurring with some other act. If a stick of wood, dipping from the car, struck the wood so negligently placed, and was hurled against plaintiff, and so caused the injury, the injury would be the result of negligence of defendant. If all these matters concur, then you are to answer the first issue, ‘Yes.’

It will be observed that this instruction ignores, or leaves out of view, the direct co-operating agency of the plaintiff, and those with whom he is identified, in running the cars, to which the accident is primarily attributable, and omits to submit to the jury the question of the plaintiff's own negligence, in bringing it about. If the piling the wood so near the track of the cars was improvident and careless, so as to expose those on and operating them, to needless peril, it was not less their duty to use reasonable care and vigilance in avoiding the consequences of the defendant's negligence, as would suggest themselves to a person of ordinary prudence for his own protection. If there was in this a failure to use such precaution, and harm followed, the plaintiff, as the author of his own damage, would be barred of redress upon the defendant, notwithstanding the prior negligence in the packing.

The true rule for determining the civil responsibility in cases where each party has been negligent, is set out in Gunter v. Wicker, 85 N.C., 310, and in Farmer v. Railroad, 88 N.C., 569, where the plaintiff’s negligence preceded that of the defendant, and was a remote, but not proximate cause, of the injury, thus: ‘If the act (of the plaintiff) is directly connected, so as to be concurrent, with that of the defendant, then his negligence is proximate, and will bar his recovery; but when the negligent act of the plaintiff precedes, in point of time, that of the

defendant, then it is held to be a remote cause of the injury, and will not bar a recovery, if the injury could have been prevented by the exercise of reasonable care and prudence on the part of the defendant.'

The correlative proposition is equally supported by authority, that when the defendant has been negligent, yet if the plaintiff neglected those reasonable precautions, by which the injury could have been averted, and which he is expected to use, he cannot have compensation for damages caused by his own want of care and prudence. Owens v. Railroad Co., 88 N.C., 502.

Now, there was much evidence upon this point. Testimony was offered to show that the plaintiff assisted in placing the wood where Nimson had pointed out, and in loading the cars and transporting to the yard, and had been in the defendant's employ from one and a half to two years previously. He had been repeatedly warned, by superior officers, of the danger of running the cars too fast; by one of them, fifteen or twenty times, and had been told that some of the men would be killed, if the rapid running was persisted in. He knew, for he says, it was no uncommon thing for the wood to be jarred and displaced when the ears were in motion, and more so when running fast. Thus warned of danger, greater circumspection and vigilance were required of him, and this aspect of the case, on the evidence, was not, as we think, fully called to the attention of the jury, in passing upon the question of the plaintiff's right of action against the company. We have assumed, though we by no means intend to decide the fact so to be, for the present only, that Nimson was, in a legal sense, as his oversight and functions are described by any of the witnesses who understood what they were, a 'middle man,' in substitution of the principal, in his relations to subordinate servants, so that his orders in regard to stacking the wood, would be the same as if emanating directly from the company, so as to raise an inquiry into the imputed co-operative agency of the plaintiff in causing his own injury.

Passing by the other exceptions, with the general remark, that most of them are obnoxious to the criticism of the plaintiff's counsel, as wanting in specific and distinct statement of assigned error, we award a new trial, to be granted in the Court below, for the error discussed in the opinion.

Error. Venire de novo."[232]

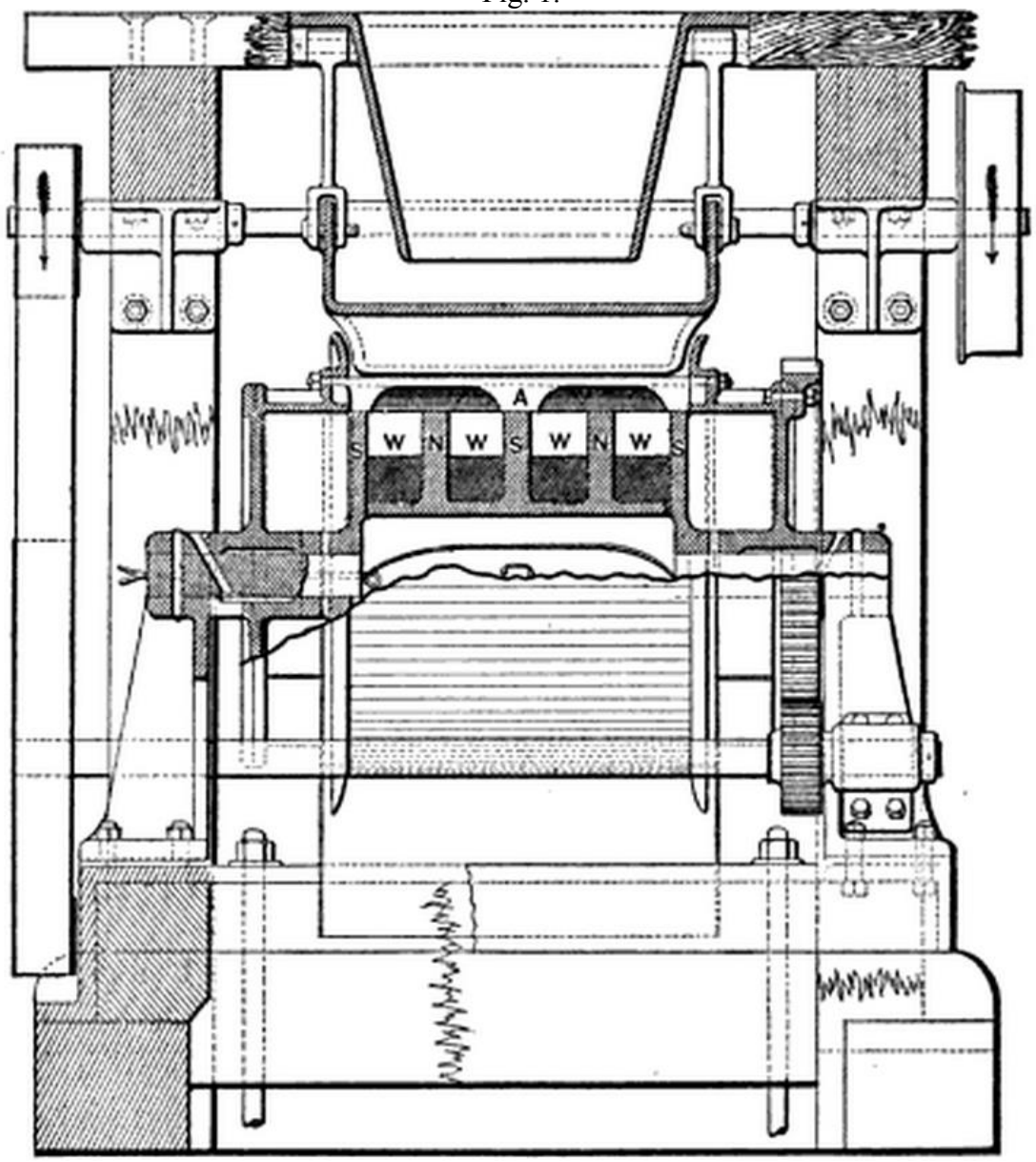
Appendix E.
"The Wenström Magnetic Separator,"
By Robert Anderson Cook…

"As the margin of profit in the manufacture of iron continues to decrease, attention is called more and more to economies in every department. Beginning at the bottom, in the preparation of the ore at the mine, we notice a general tendency is towards the shipment of richer ores, securing to the mine-owner a better price per ton, which the purchaser is glad to pay by reason of the saving in freight of iron, and in the cost of reduction, which depends so largely upon the amount of fuel and flux, and the productive capacity of the plant. In other words, the difference in value between rich and poor ores is much greater than their relative percentages of iron indicates; because the barren material in a lean ore is not merely worthless, it is a positive source of expense, requiring transportation, handling, fluxing, smelting, and its due share of general expenses; in return for which it yields nothing and decreases the available capacity of a given plant and capital for profitable work.

The enriching of the ore is done in most places by hand-picking, and in a few by wet concentration; but the managers of several magnetite mines in Sweden have been practically successful in doing it by machinery. The only magnetic separating machine which has actually taken the place of hand-picking was designed and patented by Mr. Jonas Wenström of Örebrö, Sweden.

In this machine, which is illustrated in Figs. 1 and 2, Mr. Wenström has taken advantage of the property of soft iron to become magnetized by induction. The machine consists of a barrel made up of soft iron bars and some non-conducting material (usually wood), which is rotated around a stationary shaft by means of a cog-wheel. Inside of this barrel, on the shaft, is placed eccentrically a cylindrical electro-magnet, provided with a number of flanges (N, S, Fig. 1), between which wire is wound in such a manner that the flanges are of negative and positive polarity, being energized by a current passing through the wire coils from a small dynamo. As will be seen in Fig. 1, the flanges, N, S, are circular, and follow the internal contour of the barrel on the front side, while on the opposite side they are cut down to the line B, B' in Fig. 2. Hence the bars of the revolving barrel on the front side of the machine are magnetic only while passing from B to B'; and after they pass the point B' in the lower part of the machine, they cease to be so, and remain entirely without magnetism in passing through the space from B' to B, at the back of the machine. The bars have alternately two and three projections coming close to the polar flanges, so that each bar becomes virtually a prolongation of the magnetic poles.

Fig. 1.

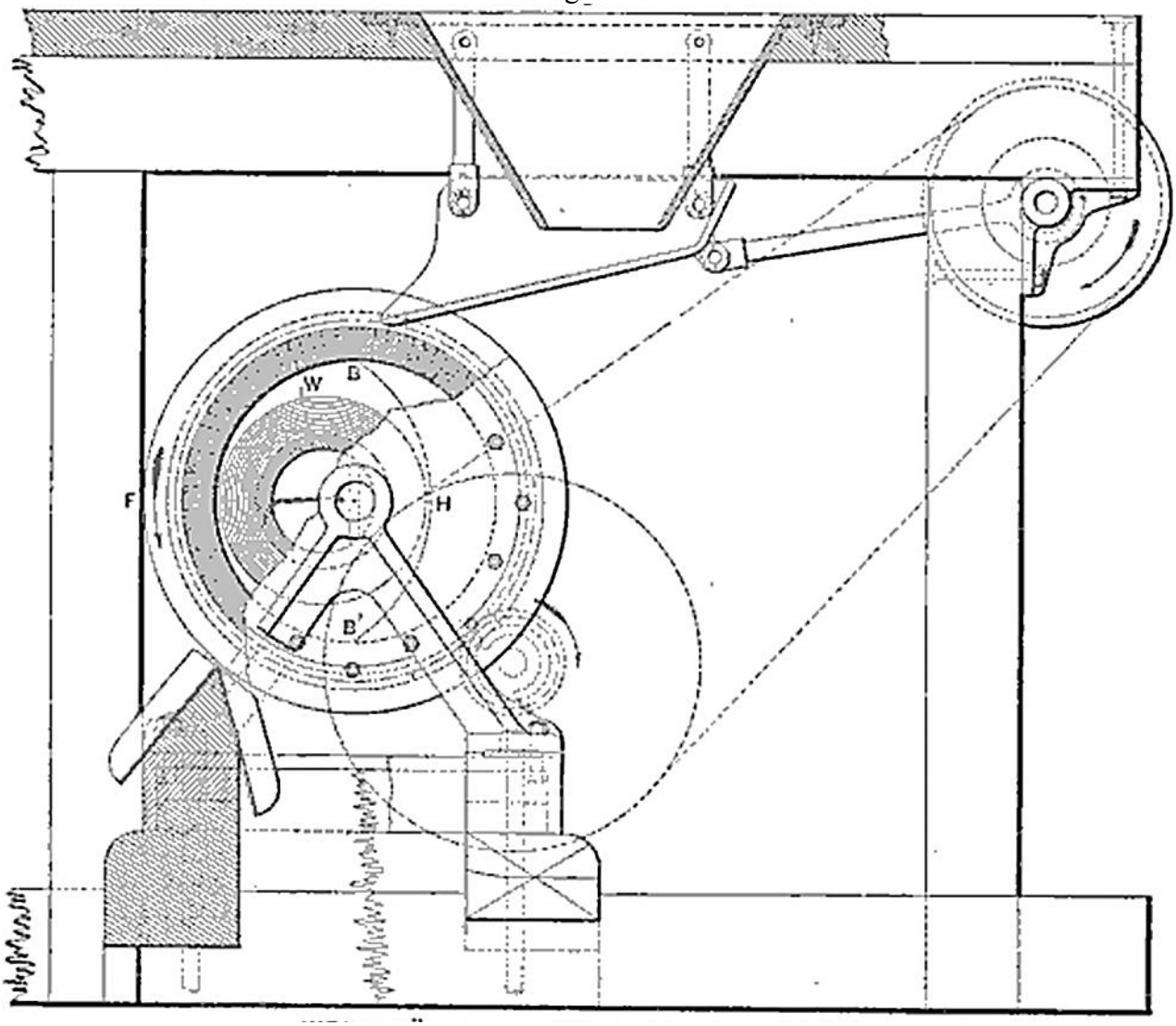


Wenström's Magnetic Ore Separator.
Cross Section
Scale: 1 in.=1 foot.

The ore and rock are fed on top of the revolving barrel, coarse and fine together, and the ore adheres to the barrel during half a revolution, being only released after it has passed out of the magnetic field at B'; the non-magnetic material rolls off the barrel and falls in front of the dividing-board, while the magnetic material drops off behind it.

Two sizes of this separator have been introduced. The largest size treats from six to seven tons of material per hour, and the magnetism is strong enough to support pieces of ore up to seven pounds in weight, and separate them from the rock. The smaller size treats from two to three tons per hour of finer material, below three-quarters of a pound in weight of single pieces.

Fig. 2.



Wenström's Magnetic Ore Separator.
Longitudinal Section
Scale: 1 in.=1 foot.

In Sweden these separators are used at the iron-mines for extracting from old and new dumps of waste material the good ore which has been missed in the hand-picking, or was too fine to be picked out in that way. They are also applied to the ore now being mined, which in former times was selected by hand. Three of the Swedish mines use the larger size of the machine, and four the smaller.

During a recent journey in Sweden (unfortunately in the winter, when the dumps were frozen and the machines idle), the writer visited five of the mines where these machines are used, and obtained the records of their working-results. It is deemed sufficient to give in this paper, as a typical example, the data thus collected at the Dannemora mine. Practice elsewhere is essentially similar, the cost varying at each mine in proportion to the handling necessarily given the ore before it comes to the separator.

The Dannemora plant (Fig. 3) consists of a separator, 24 inches on the face and 27 inches in diameter, a small dynamo, and a portable engine, which runs not only the separator but also a bucket-elevator and a hoist capable of raising a car loaded with half a ton of ore. The material, which is anything below a four-inch mesh, is dumped from a trestle at the elevator, which conveys the material to the feed of the separator, and the separated rock falls into a chute, and is thence delivered into a car, and run off to the waste dump. The ore runs down into a barrel-screen of perforated steel, the holes being one inch in diameter. The pieces which pass through fall into one car, while the coarser portion fall into another. These cars are then hoisted on the elevator and run off to the point of shipment. The fine stuff, below one-inch mesh, is kept by itself for reasons connected with the subsequent roasting. All the ore is roasted, and there is some difficulty in roasting the fine ore. Consequently not more than 5 or 10 per cent, of the charge in the roasting-kilns is permitted to be fine. The fuel used in the kiln is the tunnel-head gas from the blast-furnace.

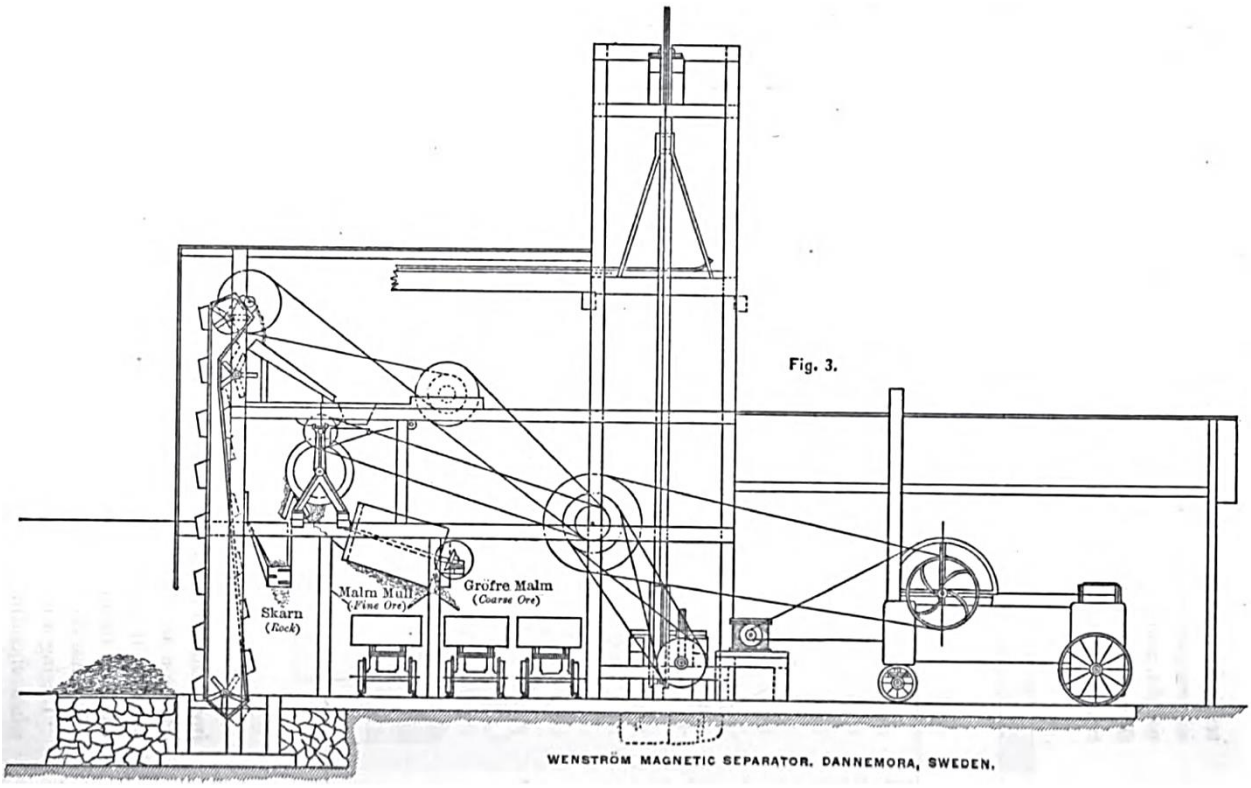


Fig. 3.

Four laborers and an engineer are required to run the machine to its full capacity, with a boy to pick out from the rock any pieces of ore which may have been mechanically knocked off by larger pieces of rock. The men's work consists of shoveling the ore into the elevator, and taking the rock and ore in the cars to the dumps. The amount of material handled averages six and a half tons per hour.

The separator was introduced in 1886, during which year no permanent plant was erected, but the machine was moved around from one small waste-heap to another. The present plant (Fig. 3) was erected in 1887, and during that year, as also in 1888, the separator was run intermittently through a season of five months. The work of the three years was as follows:

Year.	Total material treated. Tons	Ore obtained. Tons	Percentage of total material obtained as ore.	Rock Tons
1886	2000	No data		
1887	5720	3609	64	2111
1888	5169	3925	76	1244

The cost of hand-picking at Dannemora, previous to the introduction of this machine, was 32.6 cents per ton. It now costs 9.8 cents per ton,* and 30 per cent. more ore is obtained from the same material. Analyses of these ores are not frequently made, but it is known that the separated ore averages 59 per cent, iron for the coarse, and 45 per cent, for the fine. If the fine ore can be fed by itself in a somewhat different way, the results, as to that part, would be much better.

* This includes interest on plant and depreciation. The cost for repairs has been nothing, and the machine shows no wear.

Any invention adopted from a foreign country, where the plans of working, as well as the ore treated, are different from our own, must necessarily be changed to some extent to do the work required in America. Apart from this consideration, each ore must be treated in a different way. But that this invention is of practical value to us in America is demonstrated by the fact that it is used profitably in Sweden, where labor is not worth more than fifty cents per day.

There are three different cases to which this machine can be successfully applied, with only one change in the feed (namely, when the ore is below a half-inch mesh). First, where there are waste-dumps, and the run of mine has to be hand-picked. Second, where only what might be called preliminary crushing is necessary to break the greater part of the ore free from the rock, that is, by passing it through an ordinary crusher to a half-inch mesh—which ought not to cost more than fifteen cents per ton. Third, where the ore must be pulverized by further machinery to a one-quarter-inch mesh or some smaller size.

The first two of these cases are very simple, but the third is a problem by itself, in which the cost of mining, the number of tons which must be crushed to obtain one ton of concentrate, and the cost of crushing, are items of far more importance financially than the mere separation of the ore from the rock. Each mine-owner must decide for himself whether it will pay. The cost of separating ore per ton of finished product by any machine, it is impossible to give, since it varies with the richness of the ore. A Wenström machine requiring one and a half horse-power to run the dynamo, and half a horse-power, or less, to run the separator, has a capacity of fifty tons of fine (or a larger amount of coarse) material in ten hours. The feeding should be automatic, and the ore and rock should fall by their own weight into cars, so that there need be no hand-labor, except that of feeding the crusher or screen, if coarse material is to be used.

Some interesting questions arise in connection with the concentrated fine ore.

One, which the Swedish government settled to the satisfaction of its furnace-manager, is that of the use of fine ore in the furnace. It had always been supposed to be a detriment to the furnace to charge a large proportion of fine ore. Experiments were made at the expense of the government, under the charge of Mr. Granstrom, of Norberg, an eminent Swedish engineer, in the preparation of briquettes of a mixture of fine hematites crushed and concentrated to 65 per cent, of iron, with slacked lime, in a powerful brick-machine. These briquettes were very nice-looking; but, when put in the furnace, they all went to pieces. Mr. Granstrom then resolved to see exactly how much fine ore a furnace would stand. Taking one of the charcoal furnaces in his

charge, he began by using a mixture of 10 per cent, fine ore and gradually worked it up to a maximum of 75-per cent. The only change he found with the latter mixture was that the gases were a little hotter, and he was able to carry a little heavier burden on the furnace. The pressure was the same; and the conclusion reached was that the manufacture of briquettes was entirely unnecessary.

Another question concerns the effect of fine concentration in reducing such impurities of the ore as enter the pig-iron made from it. This has never yet been carried so far in practice as to convert a non-Bessemer ore into a Bessemer ore, by eliminating, through the process of concentration, the phosphorus contained in the gangue; but in all the concentrations of ores, wet or dry, the impurities have been materially reduced; and it seems not unreasonable to expect that many ores, which are but little outside the 'Bessemer limit,' will be brought within that limit, and thus made more valuable.

There are other uses to which this magnetic separator has been profitably applied in Sweden. One is that of separating the pieces of iron from the dirt, in yards where pig-iron has been stored, or from any old heaps of waste material—for instance, where the dumpings from cupolas have been piled.

One of the small Wenström machines was brought over from Sweden to this country last year, and tested with very satisfactory results on limited quantities of different ores and waste material from around steel-works. One instance in particular may be mentioned, namely, the treatment of cinder from the Bessemer converter, a material which is almost wholly thrown away at American steel-works, a small portion only being used in the blast-furnaces. A hundred pounds of this material, crushed in an ordinary Blake crusher, was run over the separator, the result being twenty-five pounds of magnetic material containing 70 per cent, of metallic iron. The same quantity of this waste product from another steelworks gave thirty-eight pounds of magnetic material.

A machine was sent, a short time ago, to the Lackawanna Iron and Coal Company, at Scranton, Pa. At these works the waste from the cupolas, and from around the runners at the converter, has been for a long time treated by putting it in a 'rumbler,' such as is used for cleaning castings at foundries, only of a larger size. The fine pieces of slag and iron are thus broken up and fall through the rumbler; and these have always been sent to the waste dump, while the coarser pieces are taken from the rumbler and sent to the cupola to be melted over again. At present, the fine waste, before it goes to the dump, is put over the Wenström separator.

The following is the result of eleven days' running (from March 3 to 13, 1889), four and a half hours per day, 198½ tons of waste being put over the machine. From this quantity there was obtained 35 tons, 3 cwt. of iron. Two men were added to the force at the rumbler to handle the material to and from the separator. The engineer was the same who ran the rumbler, and the steam for running the separator was obtained from the same boiler; so that the total expense was only two dollars and a half per day for coal, labor and oil.

The handling of converter-cinder on a large scale has not been undertaken as yet by the Lackawanna Company, the crusher required not being ready."[233]

Appendix F.
"The Concentration of Magnetic Iron Ores,"
By N.V. Hansell.

"Cobbing machines are such separators as are used for the separation of coarse crushed ore of ½ inch or so and larger. The best known types are the Wenström, the Hall, and the Gröndal. They all treat either wet or dry material.

The Wenström Separator (Figure 6) was devised in Sweden, as early as 1883. It consists of a horizontal drum built of alternating bars of wood and soft iron. The latter have projections toward the inside, alternate bars having respectively two and three such. Inside the drum, there is an electromagnet with five pole pieces in positions corresponding to the projections of the bars, and so arranged that the bars have alternately north- and south-pole magnetism. The electromagnet, which is stationary, is placed nearer one side of the drum and the pole pieces extend to its vertical diameter. The ore is fed at the top of the drum and is carried forward when it revolves. The nonmagnetic pieces drop at once, while magnetic ones are held against the soft-iron bars until they have passed the vertical diameter, where they lose their magnetism. The attracted pieces then drop into a separate receptacle. The machine is built in several sizes with various capacities up to 5 to 7 tons an hour. It is still used in the United States at Cranberry, N.C. [1910]

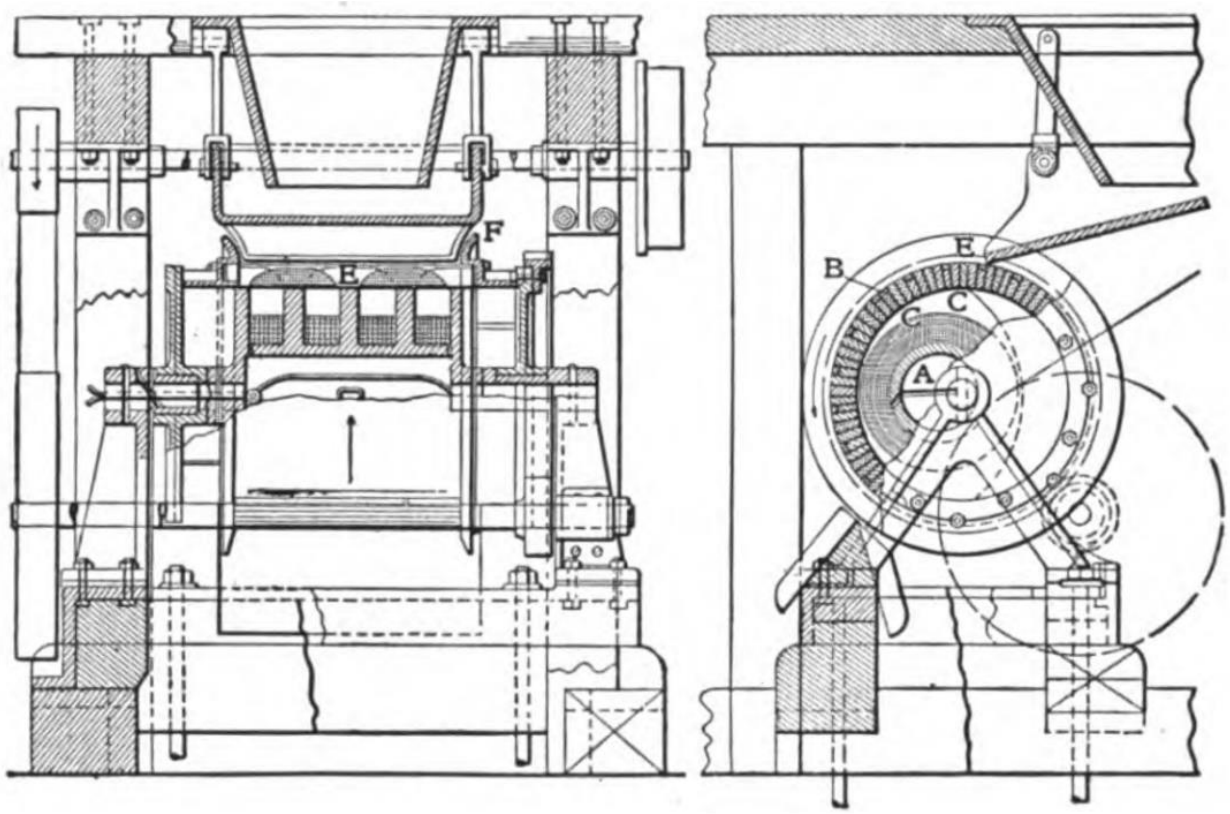


Fig. 6. Wenström Cobber."[234]

Appendix G.
Open Questions

1. Was there actually a stamp mill at Cranberry in 1887? Any technical information? Illustration or photos?

2. I recall seeing a photo of the frozen flume to blower, can anyone provide a copy?

3. Is there any additional information (technical information, serial number/construction number, etc.) on the Porter saddle tank engine at Cranberry?

4. Did the Sanborn Insurance Company make maps of the Cranberry Mine? Are they extant and can copies be secured?

5. Is there any information or images of a "Yates fine crusher"?

6. Is there any information or images of the other equipment used in the mine or its plant?

7. Are there any internal photos or layout drawings for the mine buildings?

8. Does anyone have access to good complete copies of the maps in the 1893 Nitze report?

9. Does anyone have access to better copies of figures 45 and 46?

Appendix H.
Missing References

1. General J.T. Wilder to the Iron Age in 1887

2. Illustrations of the Weimar blowing-engine in Iron Trade Review, vol. xxx. No. 4, pp. 8-9

3. 1882 map of Cranberry

Extract "Table 9. Appalachian Mountain Region mapped at 1:125,000

Quadrangle	States	Year mapping begun	Topographers
Cranberry	N.C.	1882	Morris Bien, Chas. M. Yeates, and J.W. Hays

…"[235]

Endnotes

[1] North Carolina Reports, Vol. 64, Cases Argued and Determined in the Supreme Court of North Carolina, January and June Terms, 1870, pages 275 – 279, available online at: http://digital.ncdcr.gov/cdm/compoundobject/collection/p16062coll14/id/60414/rec/34.

[2] United States Circuit Courts of Appeals Reports Containing Cases Determined in All the Circuits…, Volume 13, 1895, pages 66 – 72, available online at: https://books.google.com/books?id=t-NNAQAAIAAJ.

[3] Remembering Avery County: Old Tales from North Carolina's Youngest County, by Michael C. Hardy, 2007, page 38.

[4] "Letters from North Carolina," by Mrs. William J. Brown, in The Cultivator & Country Gentleman, 6 August 1868 (Volume XXXII, No. 812), page 90 – 91, available online at: http://books.google.com/books?id=ukoxAQAAMAAJ.

[5] "Chronicling America," available online at: http://chroniclingamerica.loc.gov/. All newspaper articles used in this document are from this source.

[6] Public Laws and Resolutions, Together with the Private Laws, of the State of North Carolina…, 1873, page 454 – 457, available online at: http://books.google.com/books?id=4ZM4AAAAIAAJ.

[7] General Robert F. Hoke, Lee's Modest Warrior, by Daniel W. Barefoot, 2001.

[8] Remembering Avery County: Old Tales from North Carolina's Youngest County, by Michael C. Hardy, 2007, page 38.

[9] General Robert F. Hoke, Lee's Modest Warrior, by Daniel W. Barefoot, 2001.

[10] Report of the Geological Survey of North Carolina, Volume I, by W.C. Kerr, 1875, pages 264 – 265, available online at: https://books.google.com/books?id=oaq_AAAAIAAJ. This report continues: "One is said to occur along the face of the same (Iron) mountain between one and two miles eastward; and several others at the distance of six to ten miles in a southeast direction. Northwestward also, beyond the State line and within a few miles of it is a number of ore-beds, mostly magnetic – one limonite; indeed it is evident that there is an extensive range of iron ores in this region, which are of the highest quality, and must one day attract a large capital for their development. Deposits of ore are also found in other parts of the county; but like the last named, they are known only by their outcrops. One of these is a bed of magnetite, on the lower slope of Little Yellow Mountain, at Flat Rock. The ore is quite like the Cranberry, of equal purity apparently, and strongly polaric. Some large blocks are found on the surface, weighing several hundred pounds, but no vein or bed of more than one or two feet, has been exposed by the slight effort at trenching recently made. Frequent specimens of menaccanite are also found at the same locality.

A bed of limonite occurs three or four miles northwest of Flat Rock, recognizable by a profusion of surface fragments, but no explorations have been made. On Rock Creek, beyond Bakersville, at the foot of the great Roan Mountain, are also several beds of magnetic ore, of which hand specimens resemble the Cranberry ore, and the geological associations are also the same. Of the size of the beds I have no definite information, except in regard to one near the mouth of Big Rock Creek, where a little trenching has been done, and a few small veins or beds of irregular shape, and one or two feet thickness, were touched. The rock is gneiss, syenite and doleryte, much decomposed superficially. Other larger deposits are said to exist near the head of the same stream. Near Bakersville, also, I have seen small outcrops of limonite.

In Ashe county, in the northwest corner of the State, there are some important ore deposits, on the waters of North Fork of New River. They lie chiefly north and northeast of Jefferson, on Horse Creek, and Helton Creek. On the former creek there are two beds of ore, both coarse, granular, highly magnetic and polaric, in gneiss and syenyte. The gangue is largely pyroxene and epidote. One is on a high mountainous ridge, some 500 feet above, and on the west side of the creek, and two miles from the river, at Hampton's; the other on the east side, at Graybill's. Both are traceable many rods by numerous surface fragments which indicate beds of considerable extent.

On Helton, six or eight miles east of the last, are still larger deposits, of very pure magnetic ore, which has been long used in the forges of the neighborhood. The ore is a coarse-grained and very pure magnetite, one of the beds of which is reported to be eighteen feet in thickness and another nine feet. This is manifestly an iron region, and worthy of a thorough investigation.

There are many other localities in this region from which hand specimens have been brought to the Museum; as for example, Cove Creek in Watauga, which has furnished both magnetite and limonite, and the neighborhood of Flat Top Mountain, where a titaniferous ore is found."

[11] "Magnetic iron Ores of the Unaka Mountains, N.C. and Tenn.," The Engineering and Mining Journal, 20 April 1878 (Volume XXV, No. 16), pages 272 – 273, available online at: https://books.google.com/books?id=j9w1AQAAMAAJ.

[12] "Magnetic iron Ores of the Unaka Mountains, N.C. and Tenn.," The Engineering and Mining Journal, 27 April 1878 (Volume XXV, No. 17), pages 293 – 294, available online at: https://books.google.com/books?id=j9w1AQAAMAAJ.

[13] Report on the Mining Industries of the United States (exclusive of the Precious Metals), with Special Investigations into the Iron Resources of the Republic and into the Cretaceous Coals of the Northwest, by Raphael Pumpelly, Washington, 1886, pages 325 – 326, available online at: https://books.google.com/books?id=dytRAAAAYAAJ.

[14] "Small Iron Mines along the Cranberry Iron Belt," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., April/May/June 1997 (Volume 9, No. 4), pages 10 – 11. Also in "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 2.

[15] Directory of Iron and Steel Works of the United States, 1880, page 172, available online at: http://books.google.com/books?id=OC4qAAAAYAAJ. This photo is also identified as: "Water Wheel Iron Foundry, Hilton's Creek, Ashe County, NC, c. 1890", Herbert Hutchinson Brimley Photograph Collection, Audio Visual Materials, State Archives of North Carolina, available online at: http://digital.ncdcr.gov/cdm/ref/collection/p16062coll34/id/543. "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 3. For information on the employment of a Catalan forge, see "A North Carolina Catalan or Bloomary Forge," by Hunter L. Harris, pages 67 – 70, in Journal of the Elisha Mitchell Scientific Society, July – December 1891 (Volume VIII, Part Second), available online at: http://books.google.com/books?id=CcMPAQAAIAAJ.

[16] This photo is also identified as: "Water Wheel Iron Foundry, Hilton's Creek, Ashe County, NC, c. 1890", Herbert Hutchinson Brimley Photograph Collection, Audio Visual Materials, State Archives of North Carolina, available online at: http://digital.ncdcr.gov/cdm/ref/collection/p16062coll34/id/544.

[17] Iron and Coal of Tennessee, by Joseph Buckner Killebrew, 1881, pages 9 – 10, available online at: http://books.google.com/books?id=1fAJAAAAIAAJ.

[18] "The Cranberry Iron Mines," The Bulletin of the American Iron and Steel Association, 2 August 1882 (Volume XVI, No. 27), page 211, available online at: https://books.google.com/books?id=RrU2AQAAMAAJ.

[19] Scientific American, 15 April 1882, page 228, available online at: http://books.google.com/books?id=zoE9AQAAIAAJ.

[20] "Reminiscences of the North Carolina Mountains," Black Diamond Express, March 1902 (Volume VI, No. 3), pages 19 – 29, available online at: https://books.google.com/books?id=AFYBAAAAYAAJ.

[21] "The Cranberry Iron Mines," The Bulletin of the American Iron and Steel Association, 2 August 1882 (Volume XVI, No. 27), page 211, available online at: https://books.google.com/books?id=RrU2AQAAMAAJ.

[22] Journal of the United States Association of Charcoal Iron Workers, November 1882 (Volume 3, No. 5), pages 321 – 323, available online at: http://books.google.com/books?id=l2dDAQAAIAAJ.

[23] "The Roanoke Meeting of the American Institute of Mining Engineers – II," The Engineering and Mining Journal, 17 March 1883 (Volume XXXV, No. 11), page 150, available online at: https://catalog.hathitrust.org/Record/000052973.

[24] "Papers of the Roanoke Meeting, June, 1883," Transactions of the American Institute of Mining Engineers, Volume XII, 1884, page 13, available online at: http://books.google.com/books?id=oGY2AQAAMAAJ.

[25] "The Roanoke Meeting of the American Institute of Mining Engineers – II," The Engineering and Mining Journal, 16 June 1883 (Volume XXV, No. 24), page 345, available online at: https://catalog.hathitrust.org/Record/000052973.

[26] Hand-book of the State of North Carolina, Exhibiting its Resources and Industries, 1883, page 43, available online at: https://catalog.hathitrust.org/Record/008652097.

[27] "The Iron Furnace at Cranberry," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., July/August/September 1994 (Volume 7, No. 1), page 11.

[28] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 7 – 11. "Iron Ores of North Carolina, A Preliminary Report," by Henry Benjamin Charles Nitze (Assistant Geologist in Charge), Bulletin 1, North Carolina Geological Survey, 1893, pages 168 – 182, available online at: http://books.google.com/books?id=JFARAQAAMAAJ.

[29] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 5. "The Iron Furnace at Cranberry," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., July, August, September 1994 (Volume 7, No. 1), pages 12 – 13, captions this same photo: "In this spectacular panoramic scene circa 1886 there are lots of things to see – mine buildings, the Cranberry depot, the company store, the mine tipple, cast house and furnace, the stock house, the building containing the waterwheel, charcoal ovens with one being burned, and the Mitchell House in the background. The flume carrying water to the water wheel is an interesting detail. The furnace has yet to be converted to coke and hot blast. In years to come these buildings will be added to and torn down and the entire foreground will be filled with mine tailings and covered with mine buildings as business interests change. Photo from the collection of Jim Dowdy." Also captioned "The old Cranberry Iron Furnace, Early 1900s…" in Remembering Avery County: Old Tales from North Carolina's Youngest County, by Michael C. Hardy, 2007. "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 4. Given the buildings present, the timeframe given by John Waite appears to be more likely.

[30] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 3.

[31] The Blue Ridge Stemwinder, An Illustrated history of the East Tennessee & Western North Carolina Railroad and the Linville River Railway, by John R. Waite, Design and Cartography by Chris H. Ford, 2003, page 40. "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 10, captions this photo: "Portrait of Cranberry mine, circa 1900".

[32] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 7 – 11.

[33] "The Great Cranberry Iron-Ore Quarry," by H.E.C. (probably Henry C. Colton), The Bulletin of the American Iron and Steel Association, 17 March 1886 (Volume XX, No. 9), page 65, available online at:

https://books.google.com/books?id=07Y2AQAAMAAJ. This was reprinted from The Iron Age, 25 February 1886, link?

[34] See also "Cranberry Iron" in The Johnson City Comet of 6 May 1886, available online at: http://chroniclingamerica.loc.gov/lccn/sn89058128/1886-05-06/ed-1/seq-1/, for additional information on the process; of note: "There is no sort of doubt but the pig made from Cranberry ore can be much improved over the output of the little furnace at the mines."

[35] The Bulletin of the American Iron and Steel Association, January 5 and 12, 1887 Volume XXI, No. 1), page 2, available online at: http://books.google.com/books?id=2LY2AQAAMAAJ.

[36] Biennial Report of the Bureau of Agriculture, Statistics, and Mines of the State of Tennessee, 1887, page 20, available online at: http://books.google.com/books?id=5gQTAAAAYAAJ.

[37] Biennial Report of the Bureau of Agriculture, Statistics, and Mines of the State of Tennessee, 1887, pages 608 – 609, available online at: http://books.google.com/books?id=5gQTAAAAYAAJ.

[38] North Carolina Reports, Vol. 99, Cases Argued and Determined in the Supreme Court of North Carolina, February Term, 1888, pages 576 – 583, available online at: https://books.google.com/books?id=aMMDAAAAYAAJ.

[39] The Bulletin of the American Iron and Steel Association, November 2 and 9, 1887 (Volume XXI, No. 39), page 306, available online at: http://books.google.com/books?id=2LY2AQAAMAAJ. Of note, this is the only reference to a stamp mill at Cranberry that the compiler has found.

[40] Ores of North Carolina, by W.C. Kerr and George B. Hanna, 1888, pages 177 – 179, available online at: http://catalog.hathitrust.org/Record/012293494. The initial portion of this section essentially restated the information given in Report of the Geological Survey of North Carolina, Volume I, by W.C. Kerr, 1875, pages 264 – 265, available online at: https://books.google.com/books?id=oaq_AAAAIAAJ, quoted above.

[41] "Mineral Resources of the United States, Calendar Year 1887," by David T. Day, The Miscellaneous Documents of the House of Representatives for the Second Session of the Fiftieth Congress, 1888 – '89, page 49, available online at: https://books.google.com/books?id=dYYZAAAAYAAJ.

[42] On Horseback: a Tour in Virginia, North Carolina and Tennessee..., by Charles Dudley Warner, 1889, page 42, available online at: http://books.google.com/books?id=_p8-AAAAYAAJ.

[43] The American Engineer, Volumes 19-20, 12 March 1890, page 121, available online at: http://books.google.com/books?id=tFsiAQAAMAAJ.

[44] The Railroad and Engineering Journal, April 1890 (Volume LXIV, No. 4), page 186, available online at: https://books.google.com/books?id=jMZLAAAAYAAJ.

[45] Engineering and Mining Journal, 12 April 1890 (Volume XLIX, No. 13), page 431, available online at: http://books.google.com/books?id=ePERAQAAMAAJ.

[46] Similar in The Gold Leaf of Henderson, North Carolina on 10 April 1890 and The Progressive Farmer of Winston, North Carolina on 29 April 1890.

[47] General Robert F. Hoke, Lee's Modest Warrior, by Daniel W. Barefoot, 2001.

[48] The Electrical World, 2 August 1890 (Volume XVI, No. 5), page 78, available online at: https://catalog.hathitrust.org/Record/008896839.

[49] The Johnson City Comet, 14 August 1890, available online at:

http://chroniclingamerica.loc.gov/lccn/sn89058128/1890-08-14/ed-1/seq-1/.

[50] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 12 – 13.

[51] Cassier's Magazine, December 1901, (Volume XXI, No. 2), page 66, available online at: https://books.google.com/books?id=1P4-AQAAIAAJ, includes: "Photograph of 13' x 24'. Weight 30,000 lbs. Jaw standard. Jaws and Pitman of open hearth steel castings. Eccentric shaft, tension rods and jaw pins of hammered steel. All Tensile Strain on Steel. Strongest and most durable Crusher on the market. Sizes from 7" x 10" to 24" x 86" single or duplex. Capacity from 100 to 1,000 tons per 10 hours. Descriptive catalogues on Ore Crushers, Magnetic Separators, Crushing Rolls and Power Transmitting Machinery sent free on application. Geo. V. Cresson Co., Philadelphia and New York., C.G. Buchanan, Conslt'g Engineer, 141 Liberty St., New York, U.S.A. Department Crushing and Concentrating Machinery."

[52] "Ore-Crushing Machines," Modern Mechanism: Exhibiting the Latest Progress in Machines, Motors, and the Transmission of Power, by Park Benjamin, 1892, page 576, available online at: https://books.google.com/books?id=bzNZAAAAQAAJ, which included: the Buchanan Crusher "is constructed upon the same principle as the Blake. The essential point of difference is in the method of supporting the movable jaw, B. In the Blake this swings on a shaft passing through its top; in the Buchanan the jaw, which has a long, horizontal projection under the pitman, C, is supported by two rocking arms, F, pivoted at their lower ends upon the base of the breaker. Consequently, every part of the jaw moves evenly back and forth. There is no other strain on the rocking arms than the weight of the jaw, which the makers claim is an advantage, as there is no direct strain due to crushing imposed on pivotal pins or shafts, as in other breakers of this type."

[53] "Progress in Magnetic Concentration of Iron-Ore," by John Birkinbine, presented at the New York Meeting of September 1890, Transactions of the American Institute of Mining Engineers, Volume XIX (May 1890 – February 1891), page 667, available online at: https://books.google.com/books?id=gDAkAQAAMAAJ. On 9 July 1885, Jonas Wenström filed for a US patent for his "Magnetic Separator," which was granted as US Patent 373,211 on 15 November 1887, available online at https://www.google.com/patents/US373211. Sweden had granted him Patent 398 for the same concept on 24 December 1884.

[54] "Some Forms of Magnetic Separators, and Their Application to Different Ores," by H.C. McNeill, Assoc. R.S.M. The Engineer, 8 September 1899 (Volume LXXXVIII), page 249, available online at: https://books.google.com/books?id=-eBV0eRC8eAC.

[55] The Dressing of Minerals, by Henry Louis, 1909,pages 393 – 395, available online at: https://books.google.com/books?id=XooNAAAAYAAJ.

[56] The East Tennessee, Virginia and Georgia Railway System, Mineral Wealth, Agricultural and Timber Resources of the Main Line and Branches…, by Henry E. Colton, 1890, page 83, available online at: http://books.google.com/books?id=GwAZAAAAYAAJ.

[57] The East Tennessee, Virginia and Georgia Railway System, Mineral Wealth, Agricultural and Timber Resources of the Main Line and Branches…, by Henry E. Colton, 1890, page 80, available online at: http://books.google.com/books?id=GwAZAAAAYAAJ.

[58] The East Tennessee, Virginia and Georgia Railway System, Mineral Wealth, Agricultural and Timber Resources of the Main Line and Branches…, by Henry E. Colton, 1890, pages 79 – 81, available online at: http://books.google.com/books?id=GwAZAAAAYAAJ. The portion that is not quoted here provides geological details similar to those presented before. This article also appeared in The Age of Steel, 3 January 1891 (Volume LXIX, No. 1), pages 28 – 29, available online at: https://books.google.com/books?id=cWoxAQAAMAAJ, see also "Steel Ores of the Southern States," by Henry E. Colton, 10 January 1891, pages 16 – 17 of the same periodical.

[59] Digital North Carolina Collection Photographic Archives, available online at:

http://dc.lib.unc.edu/cdm/singleitem/collection/dig_nccpa/id/18492/rec/28. The range of dates given for this photo are based on Along the ET&WNC, Volume I: Early Narrow Gauge Locomotives, by Johnny Graybeal, 2001, pages 16 – 17, which includes: "In 1889 the decision was made to convert the locomotives to burn coal, as the wood supply along the railroad was becoming scarce. Parts for the conversion were ordered from Baldwin (No. 1 – 5/14, No. 2 – 8/29, and No. 3 – 12/14) and applied by the railroad. This changed the appearance of the engines, replacing the short smokeboxes and Radley-Hunter stacks with extended smokeboxes and straight stacks." And Along the ET&WNC, Volume III: The Depots, by Johnny Graybeal, 2002, page 92, which includes: "Originally, the building [the Cranberry Depot] was short, had a shingle roof, and no bay window. The freight room was extended in 1903…" This photo is also on page 21 and 97 of the last two references, respectively. "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 23, included: "The small depot, originally built in early 1885, was expanded in 1903. The freight room was extended, a bay window added and a separate office room constructed."

[60] The Bulletin of the American Iron and Steel Association, 17 September 1890 (Volume XXIV, No. 34), page 269, available online at: http://books.google.com/books?id=Arc2AQAAMAAJ.

[61] "Iron Ores of North Carolina, A Preliminary Report," by Henry Benjamin Charles Nitze (Assistant Geologist in Charge), Bulletin 1, North Carolina Geological Survey, 1893, pages 225 – 226, available online at: http://books.google.com/books?id=JFARAQAAMAAJ. This table provides some indication of the days were certain types of equipment were on hand and in use at the Cranberry mine.

[62] The American Engineer, 6 December 1890 (Volume 20, No. 23), page 252, available online at: http://books.google.com/books?id=tFsiAQAAMAAJ.

[63] "On the Resources of the Middlesborough District," by Professor J.R. Proctor, State Geologist for Kentucky, The Iron and Steel Institute in America in 1890: Special Volume of 'Proceedings', Appendix II, pages 490 – 491, available online at: https://catalog.hathitrust.org/Record/008616641.

[64] The Future Situs of the Principal Iron Production of the World: Where is it?, by Edward Atkinson, 1890, page 45, available online at: http://books.google.com/books?id=PaJAAAAAYAAJ.

[65] Philadelphia Securities, A Descriptive and Statistical Manual of the Corporations of Philadelphia, by J.P. Crittenden and Charles B. Helffrich, 1891, page 124, available online at: https://books.google.com/books?id=61tCAQAAMAAJ.

[66] "Southern Magnetites and Magnetic Separation," by Harvey S. Chase, Transactions of the American Institute of Mining Engineers, Volume XXV (February 1895 – October 1895), 1896, pages 551 – 557, available online at: http://books.google.com/books?id=5gc2AQAAMAAJ. A similar, but significantly shorter article appeared in "Concentration at Cranberry, N.C.," The Mining Bulletin, December 1896 (Volume II, No. 6), pages 136 – 137, available online at: https://books.google.com/books?id=EnJCAQAAMAAJ.

[67] Engineering News and American Railway Journal, 21 July 1892(Volume XXVIII, No. 30), page 58, available online at: https://books.google.com/books?id=Ey1KAQAAMAAJ.

[68] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), cover page. "Keepin' the Steam Runnin' on the ET&WNC, Coal, Water, Sand, Oil, a Place to Keep'em and a Way to Turn 'em," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Fall/Winter 2007 (Volume 18, No. 2), page 4, captions this same photo: "The Cranberry engine house has a lean-to addition on its west side in this c. 1891 photo. The original engine house is located just east of the three-stall structure. The coal dock is south of the engine house and the turntable is located between the coal dock and the engine house. Photo from the Mallory Hope Ferrell Collection." The US Geological Survey attributes this photo to John Karl Hillers, available online at: https://www.sciencebase.gov/catalog/item/51dc83c6e4b097e4d38393b7. "Proceedings of the Seventh Annual Meeting, Held at Baltimore, December 27, 28 and 29, 1894," Bulletin of the Geological Society of America, Volume 6… 27 April 1895, pages 446, 456, available online at:

https://books.google.com/books?id=Y2I5AQAAMAAJ, note, four 10x13 photographs by J.K. Hillers of Cranberry were accepted, however, five photographs of the Cranberry mine have been located that have been attributed to J.K. Hiller. Some information on J.K. Hillers is available at: History of the Topographic Branch (Division), by Richard T. Evans and Helen M. Frye, US Geological Survey, Circular 1341, 2009, available online at: https://pubs.usgs.gov/circ/1341/pdf/circ_1341.pdf.

[69] Remembering Avery County: Old Tales from North Carolina's Youngest County, by Michael C. Hardy, 2007, which incorrectly captions this photo: "The beehive-shaped iron smelting ovens at Cranberry are illustrated in this early photograph. Iron ore smelting brought the first industry to Avery County even before the county was created…" The beehive-shaped iron smelting ovens" were in fact used for making charcoal.

[70] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 14. This photo also appeared on the cover of The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., July, August, September 1994 (Volume 7, No. 1), however, the caption read: "One of the earliest views of the Cranberry mine and furnace, circa 1885, showing the mine tipple, furnace buildings and the charcoal ovens." This photo also appeared in The Blue Ridge Stemwinder, An Illustrated history of the East Tennessee & Western North Carolina Railroad and the Linville River Railway, by John R. Waite, Design and Cartography by Chris H. Ford, 2003, pages 38 – 39, with the caption reading: "The charcoal ovens are still working in 1891, but the furnace is starting to burn coke much of the time. The 28-foot gondolas in the foreground still have link-and-pin couplers."

[71] Remembering Avery County: Old Tales from North Carolina's Youngest County, by Michael C. Hardy, 2007.

[72] Digital North Carolina Collection Photographic Archives, available online at: http://dc.lib.unc.edu/cdm/singleitem/collection/dig_nccpa/id/18503/rec/29. The tentative range of dates is based on the trestle that leads to the furnace from the railyard and the continued existence of the charcoal ovens in the lower right of the photo.

[73] The Blue Ridge Stemwinder, An Illustrated history of the East Tennessee & Western North Carolina Railroad and the Linville River Railway, by John R. Waite, Design and Cartography by Chris H. Ford, 2003, page 41. "The Iron Furnace at Cranberry," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., July, August, September 1994 (Volume 7, No. 1), page 3, captions this same photo: "From a vantage point similar to the one in [Figure 22], many changes to the furnace can be seen. Six years have brought numerous modifications, including more buildings, a magnetic separator and a roast for preparing the ore for the furnace, and a trestle for bringing loaded ore cars to the tipple at the stock house. Fewer charcoal ovens are seen as the furnace is being switched to coke. Photo from the collection of Mallory Hope Ferrell." The US Geological Survey attributes this photo to John Karl Hillers, available online at: https://www.sciencebase.gov/catalog/item/51dc83c1e4b097e4d38393b5. "Proceedings of the Seventh Annual Meeting, Held at Baltimore, December 27, 28 and 29, 1894," Bulletin of the Geological Society of America, Volume 6… 27 April 1895, pages 446, 456, available online at: https://books.google.com/books?id=Y2I5AQAAMAAJ, note, four 10x13 photographs by J.K. Hillers of Cranberry were accepted, however, five photographs of the Cranberry mine have been located that have been attributed to J.K. Hiller.

[74] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 14. Also available at Digital North Carolina Collection Photographic Archives, available online at: http://dc.lib.unc.edu/cdm/singleitem/collection/dig_nccpa/id/18525/rec/30.

[75] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 15. Also available at Digital North Carolina Collection Photographic Archives, available online at: http://dc.lib.unc.edu/cdm/singleitem/collection/dig_nccpa/id/18686/rec/32.

[76] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 15.

[77] The Blue Ridge Stemwinder, An Illustrated history of the East Tennessee & Western North Carolina Railroad and the Linville River Railway, by John R. Waite, Design and Cartography by Chris H. Ford, 2003, pages 64 – 65.

[78] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 6.

[79] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 6.

[80] Photo by John Karl Hillers, available online at: https://www.sciencebase.gov/catalog/item/51dc83cae4b097e4d38393b9. "Proceedings of the Seventh Annual Meeting, Held at Baltimore, December 27, 28 and 29, 1894," Bulletin of the Geological Society of America, Volume 6… 27 April 1895, pages 446, 456, available online at: https://books.google.com/books?id=Y2I5AQAAMAAJ, note, four 10x13 photographs by J.K. Hillers of Cranberry were accepted, however, five photographs of the Cranberry mine have been located that have been attributed to J.K. Hiller.

[81] "Basic Steel and Bessemer Pig at the South," The Railway Register, 6 August 1892 (Volume XVII, No. 30), page 233, available online at: https://books.google.com/books?id=4cgsAQAAMAAJ.

[82] "Iron Ores of North Carolina, A Preliminary Report," by Henry Benjamin Charles Nitze (Assistant Geologist in Charge), Bulletin 1, North Carolina Geological Survey, 1893, pages 31 – 32, available online at: http://books.google.com/books?id=JFARAQAAMAAJ.

[83] "Iron Ores of North Carolina, A Preliminary Report," by Henry Benjamin Charles Nitze (Assistant Geologist in Charge), Bulletin 1, North Carolina Geological Survey, 1893, between pages 172 and 173, available online at: http://books.google.com/books?id=JFARAQAAMAAJ.

[84] "Iron Ores of North Carolina, A Preliminary Report," by Henry Benjamin Charles Nitze (Assistant Geologist in Charge), Bulletin 1, North Carolina Geological Survey, 1893, pages 168 – 182, available online at: http://books.google.com/books?id=JFARAQAAMAAJ.

[85] "American Blowing Machinery," by John Birkinbine, Cassier's Magazine, Engineering Illustrated, December 1896 (Volume XI, No. 2), pages 125 – 128, available online at: https://catalog.hathitrust.org/Record/000048474.

[86] "American Blowing Machinery," by John Birkinbine, Cassier's Magazine, Engineering Illustrated, December 1896 (Volume XI, No. 2), pages 125 – 128, available online at: https://catalog.hathitrust.org/Record/000048474.

[87] "American Blowing Machinery," by John Birkinbine, Cassier's Magazine, Engineering Illustrated, December 1896 (Volume XI, No. 2), pages 125 – 128, available online at: https://catalog.hathitrust.org/Record/000048474.

[88] "American Blowing Machinery," by John Birkinbine, Cassier's Magazine, Engineering Illustrated, December 1896 (Volume XI, No. 2), pages 125 – 128, available online at: https://catalog.hathitrust.org/Record/000048474.

[89] "American Blowing Machinery," by John Birkinbine, Cassier's Magazine, Engineering Illustrated, December 1896 (Volume XI, No. 2), pages 125 – 128, available online at: https://catalog.hathitrust.org/Record/000048474, which continues: "The construction is of the bull type of blowing engine with the steam cylinder fitted with slide valves. The cylinder head is provided with a series of recessed iron boxes, the bottoms and sides of which consist of alternate openings and strips of metal, thus forming gratings or grid-irons for receiving valves; similar gratings surround the periphery of the head for the discharge valves.

The openings in these boxes were covered by a series of strips of leather suitably joined together, and the motion of these was limited by grid-iron plates against which they lifted. As the piston traversed the air cylinder, the

valves moved against the guide plate, the air passing first through the openings in the boxes, and then through slots in the leather valves and guides into the cylinder. In expelling the air, a similar arrangement was used, permitting of a large area of inlet and outlet, with but slight horizontal or vertical motion of the valves, and speeds were obtainable which practically made a relatively small engine of equal capacity with a large machine, and of greater efficiency as to steam.

An engine with a blast cylinder 60 inches in diameter and 4 feet stroke could produce as much blast as one fitted with flap valves in a blast cylinder 84 inches in diameter and 6 feet stroke of the older construction. To improve the efficiency of the engine, the piston was made with a wide face and with radial arms, the arms extending into the spaces between receiving valve boxes and the rim, and to those between the receiving and discharge valves, so as to thoroughly expel the air at the expiration of each stroke.

Various modifications of these grid-iron valves were subsequently introduced, and to secure large volumes from small compact engines, a number of disc valves, similar to those in use on compressors, closed by springs or by weights, were arranged about the cylinder heads. Some builders placed as many as 200 valves in a single head. Some of the disc valves were swung upon two parallel rods, so as to give prompt seating, and to accomplish the same purpose rectangular valves, closing against sloping grid-iron seats, were hung on metal links, or valves made of leather strips, were seated by two parallel strips of spring steel.

Valves of this character are shown in Fig. 23, which illustrates the construction of the blowing cylinder of the engines made by the Weimer Machine Works Company, of Lebanon, Pa., and this cut in connection with Fig. 22, which shows the bed-plate, housing, fly-wheels, steam cylinder, Corliss steam valve motion, piston and connecting rods and cross heads, represents a completed engine of the bull type as constructed by this company. The principal uses to which blowing engines are applied demand constant service. At a blast furnace the machinery is expected to run continuously, day and night, for many months, and stops are made only in case of some disarrangement of the furnace or its appliances. Every minute of time lost on account of repairs to blowing engines means disturbed conditions, reduced product and greater cost of manufacture…"

[90] The Journal of the Iron and Steel Institute, 1897 (Volume LI, No. 1), page 465, available online at: https://books.google.com/books?id=N8c-AQAAMAAJ.

[91] Ore Dressing, Volume I, by Robert Hallowell Richards, 1908, pages 13 – 20, available online at: https://books.google.com/books?id=1ZgLAQAAIAAJ, includes extensive information on this item of equipment, including the specifications for various sizes of crusher.

[92] The illustration on the left is taken from The Engineering and Mining Journal, 13 June 1885 (Volume XXXIX, No. 24), page 418, available online at: https://books.google.com/books?id=n0jnAAAAMAAJ. On the right: "Style of Blake Numbers 6½ to 13 inclusive" Ore Dressing, Volume I, by Robert Hallowell Richards, 1908, page 17, available online at: https://books.google.com/books?id=1ZgLAQAAIAAJ.

[93] Journal of the Elisha Mitchell Scientific Society, July – December 1892 (Volume IX, Part Second), pages 56, 57, available online at: http://books.google.com/books?id=CcMPAQAAIAAJ. This document has much information in common with "Iron Ores of North Carolina, A Preliminary Report," by Henry Benjamin Charles Nitze (Assistant Geologist in Charge), Bulletin 1, North Carolina Geological Survey, 1893, pages 168 – 182, available online at: http://books.google.com/books?id=JFARAQAAMAAJ.

[94] Chicago Journal of Commerce and Metal Industries, 20 October 1892 (Volume 61, No. 16), page 26, available online at: http://books.google.com/books?id=AYdRAAAAYAAJ.

[95] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 11.

[96] Directory to the Iron and Steel Works of the United States, 1892, pages 39, 42, available online at: http://books.google.com/books?id=XF41AAAAMAAJ.

[97] Philadelphia Securities: The Standard Statistical Manual of the Corporations of the Corporations of the City of Philadelphia, by J. P. Crittenden and Charles B. Helffrich, 1892, page 85, available online at: https://books.google.com/books?id=kYApAAAAYAAJ.

[98] "Minerals Products of North Carolina," The Engineering and Mining Journal, 15 April 1893 (Volume LV, No. 15), page 343, available online at: https://books.google.com/books?id=vJU-AQAAMAAJ.

[99] Philadelphia Securities, A Descriptive and Statistical Manual of the Corporations of the City of Philadelphia, The State of Pennsylvania and Adjacent Territory, Fourth Annual Number, by J. P. Crittenden, Charles B. Helffrich and R.V. Page, Jr., 1893, page 57, available online at: https://books.google.com/books?id=8600AQAAMAAJ.

[100] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 12.

[101] The Engineering and Mining Journal, 3 March 1894 (Volume LVII, No. 9), page 208, available online at: https://books.google.com/books?id=i3NJAQAAMAAJ.

[102] "North Carolina Iron Ores and Magnetic Concentration," by Dr. W.B. Phillips, The Engineering and Mining Journal, 26 May 1894 (Volume LVII, No. 21), page 490, available online at: https://books.google.com/books?id=i3NJAQAAMAAJ.

[103] Directory of the Iron and Steel Works of the United States and Canada, 1894, pages 37, 41, available online at: http://books.google.com/books?id=Luo7AQAAMAAJ.

[104] The Concentration and Sizing of Crushed Minerals, by Robert Edden Commans, 1894, page 76, available online at: https://catalog.hathitrust.org/Record/012308293.

[105] Photo by John Karl Hillers, available online at: https://www.sciencebase.gov/catalog/item/51dc83d2e4b097e4d38393bd. "Proceedings of the Seventh Annual Meeting, Held at Baltimore, December 27, 28 and 29, 1894," Bulletin of the Geological Society of America, Volume 6… 27 April 1895, pages 446, 456, available online at: https://books.google.com/books?id=Y2I5AQAAMAAJ, note, four 10x13 photographs by J.K. Hillers of Cranberry were accepted, however, five photographs of the Cranberry mine have been located that have been attributed to J.K. Hiller.

[106] Photo by John Karl Hillers, available online at: https://www.sciencebase.gov/catalog/item/51dc83d6e4b097e4d38393c2. "Proceedings of the Seventh Annual Meeting, Held at Baltimore, December 27, 28 and 29, 1894," Bulletin of the Geological Society of America, Volume 6… 27 April 1895, pages 446, 456, available online at: https://books.google.com/books?id=Y2I5AQAAMAAJ, note, four 10x13 photographs by J.K. Hillers of Cranberry were accepted, however, five photographs of the Cranberry mine have been located that have been attributed to J.K. Hiller.

[107] "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 5. Similar in "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 10 – 11.

[108] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 12.

[109] Engineering and Mining Journal, 21 September 1895 (Volume 60), page 282, available online at: http://books.google.com/books?id=EJY-AQAAMAAJ.

[110] American Manufacturer and Iron World, 11 October 1895, Pittsburg, page 521, available online at: http://books.google.com/books?id=vrE4AQAAMAAJ.

[111] Engineering News and American Railway Journal, 17 October 1895 (Volume XXXIV, No. 16), page 128, available online at: http://books.google.com/books?id=CC8xAQAAMAAJ.

[112] Transactions of the American Institute of Mining Engineers, Volume XXV (February 1895 – October 1895), 1896, pages 551 – 557, available online at: http://books.google.com/books?id=5gc2AQAAMAAJ. A similar, but significantly shorter article appeared in "Concentration at Cranberry, N.C.," The Mining Bulletin, December 1896 (Volume II, No. 6), pages 136 – 137, available online at: https://books.google.com/books?id=EnJCAQAAMAAJ.

[113] American Manufacturer and Iron World, 11 October 1895, Pittsburg, page 840, available online at: http://books.google.com/books?id=vrE4AQAAMAAJ.

[114] The Balsam Groves of the Grandfather Mountain: A Tale of the Western North Carolina Mountains, Together with Information Relating to the Section and its Hotels, Also a Table Showing the Height of important Mountains, Etc.," by Shepherd Monroe Dugger, 1895, pages 118 – 119, available online at: https://books.google.com/books?id=TiUXAAAAYAAJ.

[115] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 12.

[116] The Story of Coal and Iron in Alabama, by Ethel Armes, 1910, page 486, available online at: http://books.google.com/books?id=iuZYAAAAYAAJ.

[117] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 12.

[118] North Carolina and Its Resources, State Board of Agriculture, 1896, pages 96 – 97, available online at: http://digital.ncdcr.gov/cdm/compoundobject/collection/p249901coll22/id/642011/rec/47.

[119] Directory of Iron and Steel Works of the United States… Thirteenth Edition, Corrected to January 1, 1896, pages 35, 38, available online at: https://books.google.com/books?id=GQLnAAAAMAAJ.

[120] "On the Magnetite Belt at Cranberry, North Carolina, and Notes on the Genesis of this Iron Ore in General in Crystalline Schists," by James P. Kimball, pages 299 – 312, American Geologist, November 1897 (Volume XX, No. 5), available online at: http://books.google.com/books?id=hoQnCB28-ukC.

[121] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 12.

[122] Tweetsie County, by Mallory Hope Ferrell, 1976, pages 38 – 39. The Blue Ridge Stemwinder, An Illustrated history of the East Tennessee & Western North Carolina Railroad and the Linville River Railway, by John R. Waite, Design and Cartography by Chris H. Ford, 2003, page 343, notes: "The first ET&WNC stock car was added to the roster in 1898. Two more were added in 1903. All three were probably built by the railroad in Johnson City. The stock cars eventually disappeared from the line, and two new stock cars were constructed in 1926…" Along the ET&WNC, Volume IV: Freight Cars Part A, by Johnny Graybeal, 2003, pages 120 – 121, includes a detail from this photo captioned: "One of the early 32ft stock cars sits at Cranberry. The ends appear to be completely enclosed, like the later ones. Ed Bond Collection… By mid 1899, the ET&WNC had added one stock car to the roster. This was done during the period when new 32 ft cars were being built to replace the earlier, shorter cars, so this car was of that length. By mid-1902, the number of stock cars had increased to three. Three cars were the maximum number on the roster for many years…"

[123] Directory to the Iron and Steel Works of the United States, 1898, pages 35, 38, available online at: http://books.google.com/books?id=Qc9MAAAAYAAJ.

[124] Engineering and Mining Journal, 10 February 1900 (Volume 69), page 176, available online at: http://books.google.com/books?id=opk-AQAAMAAJ.

[125] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 14.

[126] Iron and Steel, 17 February 1900 (Volume 76, No. 7), page 9, available online at: http://books.google.com/books?id=feU1AQAAMAAJ.

[127] This advertisement also appeared in one or both of these same papers on 8, 15, 22, and 29 March, 5, 12, 19 and 26 April, 3, 10 May.

[128] "Southern Coal and Coke Notes," The Black Diamond, 17 March 1900 (Volume 24, No. 11), page 301, available online at: http://books.google.com/books?id=iBczAQAAMAAJ.

[129] Engineering and Mining Journal, 26 May 1900 (Volume 69), page 630, available online at: http://books.google.com/books?id=opk-AQAAMAAJ.

[130] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 14 – 16.

[131] The Iron Trade Review, 21 June 1900, page 19, available online at: http://books.google.com/books?id=_m4-AQAAMAAJ.

[132] "Miscellaneous News Notes," American Manufacturer and Iron World, 19 July 1900 (Volume LXVII, No.3), page 56, available online at: https://books.google.com/books?id=Ubg_AQAAMAAJ.

[133] Fourteenth Annual Report of the Bureau of Labor and Printing of the State of North Carolina for the Year 1900, 1901, page 27, available online at: https://books.google.com/books?id=3RwTAAAAYAAJ.

[134] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 12.

[135] The Iron Trade Review, 18 October 1900, page 21, available online at: http://books.google.com/books?id=_m4-AQAAMAAJ.

[136] Thirteenth Annual Report of the Bureau of Labor and Printing of the State of North Carolina for the Year 1899, 1900, page 310, available online at: http://books.google.com/books?id=iQJbAAAAYAAJ.

[137] "General Features of the Magnetite Ores of Western North Carolina and Eastern Tennessee," by W.S. Bayley, in Contributions to Economic Geology (Short Papers and Preliminary Reports), 1922, Part I. – Metals and Nonmetals except Fuels, US Geological Survey, Bulletin 735, 1923, page 221, available online at: https://pubs.usgs.gov/bul/0735g/report.pdf, also available online at: https://books.google.com/books?id=fp4eAQAAIAAJ.

[138] Mining Industry in North Carolina during 1900, by Joseph Hyde Pratt, The North Carolina Geological Survey, Economic Papers, No. 4, 1901, page 20, available online at: http://digital.ncdcr.gov/cdm/compoundobject/collection/p16062coll9/id/172088/rec/6.

[139] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 16.

[140] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 16.

[141] The Iron Trade Review, 29 August 1901 (Volume XXXIV, Number 35), page 25, available online at: http://books.google.com/books?id=WW8-AQAAMAAJ. For additional information on the Carnegie/Cranberry furnace at Johnson City, see "Carnegie (Cranberry) Furnace," by Robbie D. Jones and John R. Waite, The Blue

Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., October/November/December 1998, (Volume 11, No. 2), pages 8 – 14, and "Carnegie (Cranberry) Furnace," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Fall/Winter 2003, (Volume 14, No. 2), pages 3 – 6, as well as "Iron Furnace Operations," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Fall/Winter 2003, (Volume 14, No. 2), pages 7 – 24.

[142] The Tradesman, 1 September 1901 (Volume XLVI, No. 1), page 88, available online at: http://books.google.com/books?id=vWE-AQAAMAAJ.

[143] The Tennessee-Virginia Tri-cities: Urbanization in Appalachia, 1900 – 1950, 2005, page 47.

[144] Annual Report of the Virginia Iron, Coal and Coke Company and Virginia & Southwestern Railway Company, For the Year Ending June 30 1905, pages 5, 9, available online at: https://books.google.com/books?id=DY0pAAAAYAAJ

[145] Poor's Manual of Industrials, 1913, page 1169, available online at: http://books.google.com/books?id=9GY3AQAAMAAJ.

[146] The Tradesman, 15 September 1901 (Volume XLVI, No. 2), page 89, available online at: http://books.google.com/books?id=vWE-AQAAMAAJ.

[147] The Iron Trade Review, 26 September 1901 (Volume XXXIV, Number 39), page 21, available online at: http://books.google.com/books?id=WW8-AQAAMAAJ.

[148] The Tradesman, 1 November 1901, (Volume XLVI, No. 5), page 69, available online at: http://books.google.com/books?id=vWE-AQAAMAAJ.

[149] The Tradesman, 1 December 1901, (Volume XLVI, No. 7), page 69, available online at: http://books.google.com/books?id=vWE-AQAAMAAJ.

[150] The Iron Trade Review, 12 December 1901 (Volume XXXIV, Number 50), page 37, available online at: http://books.google.com/books?id=WW8-AQAAMAAJ.

[151] Engineering and Mining Journal, 28 December 1901 (Volume LXXII, No. 26), page 865, available online at: http://books.google.com/books?id=Pcs2AQAAMAAJ.

[152] Mining Industry in North Carolina during 1901, by Joseph Hyde Pratt, The North Carolina Geological Survey, Economic Papers, No. 6, 1902, pages 28 – 29, available online at: http://digital.ncdcr.gov/cdm/compoundobject/collection/p16062coll9/id/172562/rec/8.

[153] Directory of Iron and Steel Works of the United States and Canada, 1901, pages 126 – 127, 244, 247 – 248, available online at: http://books.google.com/books?id=8O3mAAAAMAAJ.

[154] The Tradesman, 15 February 1902, (Volume XLVI, No. 12), page 60, available online at: http://books.google.com/books?id=vWE-AQAAMAAJ.

[155] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 16.

[156] "Iron-Ore Deposits of the Cranberry District, North Carolina-Tennessee," by Arthur Keith, in Contributions to Economic Geology, 1902, Bulletin No. 213, US Geological Survey, by Samuel Franklin Emmons, Charles Willard Hayes, 1903, Document No. 437, U.S. House of Representatives, 2nd Session of the 57th Congress, pages 243 – 245, available online at: https://books.google.com/books?id=5W0vfBmG7NgC. This reference has considerably more information on the geology of the Cranberry mine at this time than is quoted here.

[157] The Bulletin of the American Iron and Steel Association, 25 July 1903 (Volume XXXVII, No. 14), page 106, available online at: https://books.google.com/books?id=uScjAQAAMAAJ. Also in "Blast Furnace Operations During the Half Year," The Iron and Machinery World, 8 August 1903 (Volume 94, No. 6), page 19, available online at: https://books.google.com/books?id=YFA-AQAAMAAJ.

[158] The Iron and Machinery World, 8 August 1903 (Volume 94, No. 6), page 19, available online at: http://books.google.com/books?id=YFA-AQAAMAAJ.

[159] American Manufacturer and Iron World, 8 December 1904, (Volume 75, No. 23), page 723, available online at: http://books.google.com/books?id=1EMAAAAAMAAJ.

[160] Mining Industry in North Carolina during 1904, by Joseph Hyde Pratt, The North Carolina Geological Survey, Economic Papers, No. 9, 1905, page 20, available online at: http://digital.ncdcr.gov/cdm/compoundobject/collection/p16062coll9/id/172360/rec/12.

[161] The Railway Age, 28 April 1905 (Volume XXXIX, No. 17), page 107, available online at: https://books.google.com/books?id=m1JBAQAAMAAJ.

[162] The Iron Age, Volume LXXV, 16 March 1905, page 940, available online at: http://books.google.com/books?id=kKE-AQAAMAAJ.

[163] The Iron Trade Review, 16 March 1905 (Volume XXXVIII, Number 14), page 53, available online at: http://books.google.com/books?id=GvowAQAAMAAJ.

[164] The Iron and Machinery World, 10 June 1905 (Volume 97, No. 23), page 23, available online at: http://books.google.com/books?id=VVQ-AQAAMAAJ.

[165] Directory of Iron and Steel Works of the United States, Seventeenth Edition, 1908, page 415, available online at: https://books.google.com/books?id=vO7mAAAAMAAJ.

[166] The Iron Age, 13 June 1907 (Volume 79, No. 24), page 1818, available online at: https://books.google.com/books?id=XvQ9AQAAMAAJ.

[167] The Iron Trade Review, 17 December 1908 (Volume XLIII, Number 25), page 1033, available online at: http://books.google.com/books?id=ZZJBAQAAMAAJ.

[168] Directory of Iron and Steel Works of the United States, 1908, pages 338, 415, available online at: http://books.google.com/books?id=vO7mAAAAMAAJ.

[169] Ore Dressing, Volume III, by Robert Hallowell Richard, 1909, pages 1530 – 1531, available online at: http://books.google.com/books?id=0NxAAQAAIAAJ.

[170] Ore Dressing, Volume IV, by Robert Hallowell Richards, 1909, pages 1817 – 1818, available online at: http://books.google.com/books?id=CtVAAQAAIAAJ.

[171] "Gates Crusher for Marquette Ores," The Iron Trade Review, 19 May 1898 (Volume XXXI, No. 20), page 13, available online at: https://books.google.com/books?id=ahmYD4WAca4C.

[172] Ore Dressing, Volume I, by Robert Hallowell Richards, 1908, page 37, available online at: https://books.google.com/books?id=1ZgLAQAAIAAJ.

[173] "Gates Crusher for Marquette Ores," The Iron Trade Review, 19 May 1898 (Volume XXXI, No. 20), page 13, available online at: https://books.google.com/books?id=ahmYD4WAca4C, which continues: "The Gates breaker is of the gyratory form. The crushing is done between a cone placed on a gyratory shaft vertical through the center of a cylindrical shell. As it gyrates, the crushing cone impinges against the sides of the shell in relation to which it is

constantly approaching and receding. The top of the shaft carrying the crushing cone is held rigidly which the bottom is gyrates (with a certain amount of eccentricity, depending on the size of the machine) by means of a simple gearing. The diameter of the breaking head corresponds nearly to the width of the jaw in the jaw breaker receiving the same size of material. At the same time the circumference of the head of the Gates crusher is three times the width of the opening in the jaw crusher, and a complete gyration is made in the time required for the jaw crusher to approach and recede. Thus the amount of material operated on in a given time is multiplied in the case of the gyratory breaker. To compensate for the wear on the head and concaves of the machine, the head of the Gates breaker can be raised. In a new crusher the head and concaves are put in to suit the requirements. Where the product wanted varies considerably in size extra liners can be put in as required. The inner surface of the liners being concave in form, a space is left behind the central portions of the pieces of rock or ore, which, as they drop into place, are supported only at each end. This facilitates a clean break when struck in the center by the gyrating head or cone, and less power is necessary…"

[174] "The Concentration of Magnetic Iron Ores," by N.V. Hansell, The Engineering Magazine, January 1910 (Volume XXXVIII, No. 4), pages 519 – 520, available online at: https://books.google.com/books?id=7BHOAAAAMAAJ. See the entry for February 1889, above, for the complete text of this section.

[175] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 20, 28, included: "A number of buildings were added to the mine complex over the years. These buildings were constructed on a plateau formed with waste rock from the mine." Also photo is also available at Digital North Carolina Collection Photographic Archives, available online at: http://dc.lib.unc.edu/cdm/singleitem/collection/nc_post/id/979/rec/11. "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 12, captions this photo: "Portrait of newly upgraded mine operations, circa 1905".

[176] "The Cranberry Mine, Methods at a North Carolina Iron Ore Property," by B.C. Hodgson (Knoxville, Tennessee), Mine and Quarry, May 1911 (Volume V, No. 4), pages 509 – 512A, available online at: http://books.google.com/books?id=kzI5AQAAMAAJ.

[177] "The Cranberry Mine, Methods at a North Carolina Iron Ore Property," by B.C. Hodgson (Knoxville, Tennessee), Mine and Quarry, May 1911 (Volume V, No. 4), pages 509 – 512A, available online at: http://books.google.com/books?id=kzI5AQAAMAAJ.

[178] "The Cranberry Mine, Methods at a North Carolina Iron Ore Property," by B.C. Hodgson (Knoxville, Tennessee), Mine and Quarry, May 1911 (Volume V, No. 4), pages 509 – 512A, available online at: http://books.google.com/books?id=kzI5AQAAMAAJ.

[179] "The Cranberry Iron Ore Mine, Large Deposit of High-Grade Magnetite, Methods of Mining and Electric Concentrating," by J.M. Cameron, M.E. (Johnson City), Mines and Minerals, August 1911 (Volume XXXII, No. 1), pages 42 – 44, available online at: http://books.google.com/books?id=25I5AQAAMAAJ. Although this article uses the many of the same photos as those used in "The Cranberry Mine, Methods at a North Carolina Iron Ore Property," by B.C. Hodgson in the May 1911 edition Mine and Quarry, the text is sufficiently different to include both articles. The photos are retained in order to prevent cumbersome referencing. "The Cranberry Mine, Methods at a North Carolina Iron Ore Property," by B.C. Hodgson describes J.M. Cameron as the "general superintendent of the company…"

[180] "The Cranberry Iron Ore Mine, Large Deposit of High-Grade Magnetite, Methods of Mining and Electric Concentrating," by J.M. Cameron, M.E. (Johnson City), Mines and Minerals, August 1911 (Volume XXXII, No. 1), pages 42 – 44, available online at: http://books.google.com/books?id=25I5AQAAMAAJ.

[181] Industrial World, 16 October 1911 (Forty-Fifth Year, No. 42), page 1243, available online at: https://books.google.com/books?id=KK04AQAAMAAJ. See also pages 1268,

[182] The Mining Industry in North Carolina during 1911 and 1912, Economic Paper No. 34, by Joseph Hyde Pratt, 1914, pages 72 – 73, available online at: http://books.google.com/books?id=wC1NAAAAMAAJ.

[183] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 28.

[184] Poors Manual of Industrials, Volume 7, 1916, page 1684, available online at: http://books.google.com/books?id=F3QiAQAAMAAJ.

[185] The Blue Ridge Stemwinder, An Illustrated history of the East Tennessee & Western North Carolina Railroad and the Linville River Railway, by John R. Waite, Design and Cartography by Chris H. Ford, 2003, page 82. Tweetsie County, by Mallory Hope Ferrell, 1976, page 52, captioned this photo: "In the early 1900's the Cranberry shops (above) were busy with the engines of the ET & WNV, LR and Cranberry Iron's own 0-4-0T (Top). – Ed Bond Coll."

[186] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 28.

[187] "Report on the Forest Tract Owned by the Cranberry Iron and Coal Company, Cranberry, N.C.," by J.S. Holmes, State Forester, Biennial Report of the State Geologist, 1915 – 1916, 1917, page 62, available online at: http://digital.ncdcr.gov/cdm/compoundobject/collection/p249901coll22/id/748062/rec/102.

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[189] "Obituary, Frank Firmstone," The Iron Age, 12 July 1917 (Volume 100, No. 2), page 112, available online at: https://books.google.com/books?id=Gc4cAQAAMAAJ.

[190] Transactions of the American Society of Civil Engineers, 1917 (Volume LXXXI), page 1711, available online at: https://books.google.com/books?id=QXBDAAAAYAAJ.

[191] Poor's Manual of Industrials; Manufacturing, Mining and Miscellaneous Companies, 1918, page 288, available online at: http://books.google.com/books?id=rWY3AQAAMAAJ.

[192] "General Features of the Magnetite Ores of Western North Carolina and Eastern Tennessee," by W.S. Bayley, in Contributions to Economic Geology (Short Papers and Preliminary Reports), 1922, Part I. – Metals and Nonmetals except Fuels, US Geological Survey, Bulletin 735, 1923, page 221, available online at: https://pubs.usgs.gov/bul/0735g/report.pdf, also available online at: https://books.google.com/books?id=fp4eAQAAIAAJ.

[193] Moody's Manual of Railroads and Corporation Securities, 1919, page 200, available online at: http://books.google.com/books?id=Vxs-AQAAMAAJ.

[194] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 28.

[195] "Highway Work in North Carolina," Highway Engineer and Contractor, A Journal of State and City Engineering and Construction Problems, October 1919 (Volume 1, No. 6), page 22, available online at: https://catalog.hathitrust.org/Record/000546531.

[196] "Operation of Cranberry Iron Mine," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring 1988 (Volume 1, No. 1), pages 3 – 4. Similar in "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co.,

Spring/Summer 2007 (Volume 18, No. 1), pages 20 – 22, which included: "The yard area included the crusher and tipple, the boiler house, compressor house, 'check out' building, hoist house, and several materials storage buildings, as well as the railroad roundhouse and tracks. Steam was generated in the large boiler house and fed to the mine operations through a system of steam pipes."

[197] American Mining Manual, 1920, pages 292, 306, available online at: http://books.google.com/books?id=V94kAQAAIAAJ.

[198] Moody's Manual of Railroads and Corporation Securities, Twenty-Second Annual Number, Industrial Section (Volume I – A to J), 1921, pages 444 – 445, available online at: https://books.google.com/books?id=OJ9IAQAAMAAJ.

[199] The Blast Furnace and Steel Plant, May 1922 (Volume X, No. 5), page 300, available online at: https://books.google.com/books?id=Sxg4AQAAMAAJ.

[200] Moody's Analyses of Investments and Security Rating Books, by John Moody, 1922, page 443, available online at: http://books.google.com/books?id=jZo9AQAAMAAJ.

[201] The American Mining Manual, 1922 Edition Thirtieth Year, Embracing the Mining, Dredging, Smelting and Refining Iron and Steel Companies of the United States, Canada, and Mexico, Western U.S., Canada & Mexico Collieries, by Alexander R. Dunbar, 1922, page 368, available online at: https://catalog.hathitrust.org/Record/100616639.

[202] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 20 -21. This same photo appears in Tweetsie County, by Mallory Hope Ferrell, 1976, page 14; however, it is attributed to "L.A. Tolley Coll." "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 13. Another source, Logging Railroads of the Blue Ridge and Smoky Mountains, Volume I, Cold Mountain, Black Mountain and White Top, by Thomas Fetters, 2007, page 104, raises an interesting point in his caption: "Although this photo by L.A. Tolley has been identified as being from around 1920, the presence of the 2-truck Shay at the far left, probably the Linville River Railway No. 1, would mean that his was more likely taken about 1905. At least seven of the ET&WNC ore gondolas can be found; two in front of the outhouse at the center of the lower level with a third just to the right behind the large building. Two more are behind the mill at the far right and the final two are just behind the Shay. Four men can be seen climbing the stair from the lower level of the Cranberry Iron & Coal Company in the center of the photo. (Collection of R.D. "Doug" Walker"). Along the ET&WNC, Volume I: Early Narrow Gauge Locomotives, by Johnny Graybeal, 2001, page 79, states that the Linville River Shay continued to operate in the area around Cranberry until 1915. Given that four smoke stacks rise from the boiler house indicate a later date, it is most likely that the Shay is from one of the other logging operations that worked the area around Cranberry in the late 1910s or early 1920s.

[203] Cy Crumley's Tweetsie, Ninety Years on the Narrow Gauge, by Kenneth Riddle, 2001, unpaginated, captioned "Cranberry Mines, 1923", this photo also appeared in The Blue Ridge Stemwinder, An Illustrated history of the East Tennessee & Western North Carolina Railroad and the Linville River Railway, by John R. Waite, Design and Cartography by Chris H. Ford, 2003, page 83, with the caption: "The Cranberry mine complex is across the valley from the company swimming pool. The pool provides a convenient way for workers to wash off dirt and grime in the 1920s. James T. Dowdy Collection." "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 14.

[204] The Magnetic Iron Ores of East Tennessee and Western North Carolina, by W.S. Bayley, Bulletin 29, State of Tennessee Division of Geology, 1923, pages 98 – 117, available online at: http://books.google.com/books?id=vBnwAAAAMAAJ.

[205] The Magnetic Iron Ores of East Tennessee and Western North Carolina, by W.S. Bayley, Bulletin 29, State of Tennessee Division of Geology, 1923, pages 98 – 117, available online at:

http://books.google.com/books?id=vBnwAAAAMAAJ. Pages 23 – 34 provide additional information on the early history of the Cranberry mine. See also "Small Iron Mines along the Cranberry Iron Belt," by John Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., April/May/June 1997 (Volume 9, No. 4), pages 8 – 12.

[206] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 20. "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 15.

[207] The Blue Ridge Stemwinder, An Illustrated history of the East Tennessee & Western North Carolina Railroad and the Linville River Railway, by John R. Waite, Design and Cartography by Chris H. Ford, 2003, page 84. Tweetsie County, by Mallory Hope Ferrell, 1976, page 52, captioned this photo: "In the early 1900's the Cranberry shops (above) were busy… Ed Bond Coll." "Keepin' the Steam Runnin' on the ET&WNC, Coal, Water, Sand, Oil, a Place to Keep'em and a Way to Turn 'em," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Fall/Winter 2007 (Volume 18, No. 2), page 3, captions this same photo: "The original engine house at Cranberry is still standing next to the newer Cranberry engine house and the mine is in full production in this view from the World War I years. Photo from the James T. Dowdy Collection."

[208] Herbert Hutchinson Brimley Photograph Collection, Audio Visual Materials, State Archives of North Carolina, available online at: http://digital.ncdcr.gov/cdm/ref/collection/p16062coll34/id/517.

[209] "Cranberry, NC, Iron Mining Village, 1925," Herbert Hutchinson Brimley Photograph Collection, Audio Visual Materials, State Archives of North Carolina, available online at: http://digital.ncdcr.gov/cdm/ref/collection/p16062coll34/id/508.

[210] "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 17. Similar in "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 12 – 13.

[211] "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 11. Similar in "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 15.

[212] The Cumulative Daily Digest of Corporation News, 1925, page 331, available online at: https://catalog.hathitrust.org/Record/101868843.

[213] The Mining Industry in North Carolina during 1926, by Herman J. Bryson, State Geologist, North Carolina Department of Conservation and Development, Economic Paper Number 62, 1928, pages 17 – 19, available online at: http://digital.ncdcr.gov/cdm/ref/collection/p16062coll9/id/176666.

[214] Mining industry in North Carolina during 1927 and 1928, by Herman J. Bryson, State Geologist, North Carolina Department of Conservation and Development, Economic Paper Number 63, 1930, page 31, available online at: http://digital.ncdcr.gov/cdm/compoundobject/collection/p16062coll9/id/176827/rec/9.

[215] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 28, 30.

[216] Mining Industry in North Carolina from 1929 to 1936, Inclusive, by Herman J. Bryson, State Geologist, North Carolina Department of Conservation and Development, Economic Paper Number 64, 1937, page 35, available online at: http://digital.ncdcr.gov/cdm/ref/collection/p16062coll9/id/176969.

[217] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 31.

[218] The Mining Industry in North Carolina From 1937 to 1945, by Thomas G. Murdock, Assistant State Geologist, North Carolina Department of Conservation and Development, Economic Paper Number 65, not dated, pages 11 – 12, available online at: http://digital.ncdcr.gov/cdm/compoundobject/collection/p16062coll9/id/177042/rec/2.

[219] "Cranberry Mine Historical Overview, Photos and Maps," a presentation by Chris H. Ford, undated, received 12 October 2017, slide 16.

[220] Pilot-Plant Production of High-Grade Magnetite Concentrates, Cranberry, N.C., by Frank D. Lamb and D.A. Woodward, R.I. 3980, Bureau of Mines, United States Department of the Interior, December 1946, available online at: https://catalog.hathitrust.org/Record/005982776.

[221] Cranberry Magnetite Deposits, Avery County, N.C., and Carter County, Tenn., by M.H. Kline and T.J. Ballard, May 1948, R.I. 4274, available online at: https://catalog.hathitrust.org/Record/005949568. The section reading "In 1876, in a report by S.T. Abert to the Chief of Engineers, U.S. Army, attention was called to the construction of a railroad from Johnson City, Tenn., to Cranberry to transport the ore to the furnaces in Tennessee. He estimated that not over 50,000 tons of ore had been mined at Cranberry… Abert, S.T., Examination of Catawba River from South Carolina line to Old Fort, North Carolina: Chief of Engineers, U.S. Army, Rept. For 1876, pt. 1, pp. 367 – 376. appendix G, 1876" is not supported by this report, which is available online at: https://books.google.com/books?id=h_oWAQAAIAAJ. See also "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), page 31.

[222] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 18 – 19.

[223] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 18 – 19.

[224] "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1), pages 31 – 32.

[225] Western North Carolina: A History (from 1730 to 1913), by John Preston Arthur, 1914, pages 276 – 280, available online at: https://books.google.com/books?id=zX98AAAAMAAJ. A detailed description of the forge on Helton Creek is given in: "A North Carolina Catalan or Blomary Forge," by Hunter L. Harris, Journal of the Elisha Mitchell Scientific Society, July – December 1891 (Volume VIII, Part Second), pages 67 – 70, available online at: http://books.google.com/books?id=CcMPAQAAIAAJ.

[226] "Report of the Geologist of the State, Submitted to the House of Representatives, 5th October, 1837," by G. Troost, Geologist of the State, Journal of the House of Representatives of the State of Tennessee, at the Twenty-Second General Assembly, Held at Nashville, 1838, pages 632, 645, available online at: https://books.google.com/books?id=MTcwAQAAMAAJ. Also in Fourth Geological Report to the Twenty-Second General Assembly of the State of Tennessee, Made October, 1837, by Gerard Troost, 1837, pages 9, 28, available online at: https://books.google.com/books?id=2fZNAAAAYAAJ.

[227] Western North Carolina: A History (from 1730 to 1913), by John Preston Arthur, 1914, pages 557 – 558, available online at: https://books.google.com/books?id=zX98AAAAMAAJ.

[228] The Iron Manufacturer's Guide to the Furnaces, Forges and Rolling Mills of the United States…, by J. Peter Lesley, 1866, page 191, available online at: http://books.google.com/books?id=eCdWAAAAcAAJ. Similar in The Iron Manufacturer's Guide to the Furnaces, Forges and Rolling Mills of the United States..., by J. Peter Lesley, 1859, page 191, available online at: https://books.google.com/books?id=NSJDAAAAIAA.

[229] "History of the Cranberry 'Ore Bank,'" The Bulletin of the American Iron and Steel Association, 30 December 1891 (Volume XXV, No. 49), page 385, available online at:

https://books.google.com/books?id=ULc2AQAAMAAJ. See also "Cranberry, North Carolina," by John R. Waite, The Blue Ridge Stemwinder, East Tennessee and Western North Carolina R.R. Co., Spring/Summer 2007 (Volume 18, No. 1).

[230] United States Circuit Courts of Appeals Reports Containing Cases Determined in All the Circuits…, Volume 13, 1895, pages 66 – 72, available online at: https://books.google.com/books?id=t-NNAQAAIAAJ.

[231] Public Laws and Resolutions, Together with the Private Laws, of the State of North Carolina…, 1873, page 454 – 457, available online at: http://books.google.com/books?id=4ZM4AAAAIAAJ.

[232] North Carolina Reports, Vol. 99, Cases Argued and Determined in the Supreme Court of North Carolina, February Term, 1888, pages 576 – 583, available online at: https://books.google.com/books?id=aMMDAAAAYAAJ.

[233] "The Wenström Magnetic Separator," by Robert Anderson Cook, Transactions of the American Institute of Mining Engineers, Volume XVII (May 1888 to February 1889), pages 599 – 606, available online at: https://books.google.com/books?id=__kNAQAAIAAJ.

[234] "The Concentration of Magnetic Iron Ores," by N.V. Hansell, Engineering Magazine, In Industrial Review, January 1910 (Volume XXXVIII, No. 4), page 520, available online at: http://books.google.com/books?id=7BHOAAAAMAAJ.

[235] History of the Topographic Branch (Division), by Richard T. Evans and Helen M. Frye, US Geological Survey, Circular 1341, 2009, page 43, available online at: https://pubs.usgs.gov/circ/1341/pdf/circ_1341.pdf.