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Tyson Furnace

Early Copper Smelting in Vermont*

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BEFORE Michigan became a byword in the copper industry, even before the erection of smelting plants on the Atlantic seaboard in the 1840s, Vermont became the scene of the first large scale attempt to smelt copper ores at a mine.

The place was South Strafford; the time, the 1830s.

The mine, after its discovery in 1793[1], had gradually taken first place in the United States production of copperas, or iron sulphate, which was extensively used in dyeing, and as a medicine and disinfectant. Chalcopyrite, a copper ore, was intimately mixed with the copperas ore (pyrrhotite), but not exploited for forty years.

When the prosperity of the late 1820s and more efficient production of copperas coincided, the proprietors of the Vermont Mineral Factory Company, which owned the deposits on Copperas Hill, decided to try to separate and smelt the copper. In 1830 land and water rights were bought and construction was begun on a copper smelting plant. Smelting may have started that same year, and was definitely in full swing by 1831.[2]

The operators of the mine had been aware of the presence of copper as early as 1820, if not before, because, in purifying the copperas they were precipitating the copper with scrap iron and getting a residue which they called copper mud.[3] This was the same product later operators called copper cement.

* Published in revised form from an essay originally appearing in the *New-England Galaxy*, Fall 1964, by permission.

1. *Niles' Register*, XXXIII (Nov. 17, 1827), 181. This is the earliest reference to the discovery I have found. A firm tradition sets the discovery date in 1793, but I have found no documentary evidence.

2. Land Records of Strafford, Vt., Book 7, 422, 424, 428, 515; Book 8, 79, 163, 164. Sources conflict but town records indicate that land and water rights were purchased in 1830. Construction probably began the same year and some structures were complete in 1831.

3. John Locke, "Some Account of the Copperas Mines and Manufactory in Strafford, Vt." in the *American Journal of Science and Arts*, III (1821), 328.

It is doubtful that any effort was made to smelt or refine this copper mud. The big effort to extract and smelt copper ore did not come until 1830 or 1831 after considerable preparation. The plant remained in operation until 1839 and when it died it was buried by historians with only passing mention. The fact that it was the forerunner of the first large custom smelting plants established at Point Shirley near Boston by the Revere Copper Company and at Baltimore by the Baltimore and Cuba Smelting and Mining Company in the 1840s was overlooked.[4]

The principal financial backers of this unusual venture in the hinterland of Vermont were Boston men. One key individual was Colonel Amos Binney, a well-to-do merchant, land speculator and promoter of industry, who had been agent of the United States Navy Yard at Charlestown from 1812 to 1826. Colonel Binney was responsible for the visit of President James Monroe to the copperas works in 1817 when the agitation was in full swing for a higher tariff to protect the infant industry from the flood of low priced British imports.[5]

Another key man was Colonel Binney's son, also named Amos, who had been educated at Dartmouth, Brown and Harvard, but never practiced his chosen profession of medicine. Instead, he went into business with his father in 1826 and pursued his hobbies of conchology and natural history diligently enough to become a nationally known authority. Doctor Binney was also interested in geology and the increase in activity at Copperas Hill occurred shortly after he became associated with his father.[6]

There were more "money men" involved, for at this period speculation in and exploration of northern New England's mineral wealth were unusually widespread. Among the other important supporters were members of the Reynolds family, William, William B. and John, who were wealthy commission merchants with offices near the Binneys on Boston's waterfront. The Reynoldses came onto the scene in the early

4. Thomas Egleston, "Point Shirley Copper Works" in School of Mines *Quarterly*, VII (1886), 360–384; R. Brent Keyser, "Copper" in *Maryland, its Resources, Industries and Institutions* (Baltimore: Board of World's Fair Managers, 1893), 115–117. On the basis of these two accounts, it appears that the Baltimore works got into successful operation somewhat later than the Revere works.

5. Justin Winsor, ed., *The Memorial History of Boston, 1630–1880.* (Boston: James R. Osgood & Co., 1882), 339; Charles J. F. Binney, *Genealogy of the Binney Family in the United States* (Albany: Joel Munsell's Sons, 1886), 74; the visit of President Monroe is described in William Belmont Parker's *The Life and Public Services of Justin Smith Morrill* (New York: Houghton Mifflin & Co., 1924), 22.

6. Charles J. F. Binney, *op. cit.*, 128–130; also in the introduction to *The Terrestrial Air-Breathing Mollusks of the United States of America* by Amos Binney (Boston: Charles C. Little and James Brown, 1851), xi–xxvi.

1800s as handlers of the copperas output and their descendants were connected with Vermont's copper industry for more than a century.[7]

This was the setup in 1830 when preparations for smelting copper got under way. By the next year two furnaces were in operation and two more were being built, The ore was taken from underground stopes (ventilated by a 100-foot air shaft to the top of the hill) in tram cars through a 125-foot adit, or tunnel, to the surface, where it was cobbed (that is, separated by men with hammers), roasted and then smelted in three successive meltings to produce the metal.[8]

The adit for a haulageway and the shaft suggest that preparatory work was started as early as 1827 when the number of workmen was increased.[9] Driving such a tunnel, with the primitive tools then employed, might well have taken two or three years. Up to that time, the copperas ore had been mined only from an open cut, so the adit and underground galleries were an important innovation.

Evidence that the undertaking was no fly-by-night affair is contained in an 1832 report by Amos Binney that the Copperas Hill plant represented a $60,000 investment.[10] The original financial arrangements between Isaac Tyson Jr. and the Vermont Mineral Factory Company and Doctor Binney are significant. According to this agreement, the Vermont Mineral Factory Co. was to advance $10,000, Doctor Binney pledged $9,000 and Tyson was to put in $6,000, a total of $25,000 for the copper plant alone.[11]

In April 1834 the promoters voted to borrow $30,000 to put into the business and, from time to time, sums totaling several thousand dollars in one lump were obtained to finance improvements, additions and maintenance. Everything points to the conclusion that the proprietors intended to make South Strafford a substantial copper producer despite obviously gigantic hurdles. Although there is no evidence that they spent it, the ambitious hopes of the incorporators are revealed in the

7. Boston City Directories of various years; William Reynolds first bought property in Strafford in 1813, Strafford Land Records, Book 4, 232. Some history of the Reynolds family is contained in William R. Cutter, ed., *New England Families, Genealogical and Memorial* (New York: Lewis Historical Publishing Co., 1913), II, 889.

8. "Copper Ore of Strafford, Vt., etc., extracted from a letter to Mr. C.U. Shepard, from Mr. Richardson of Franconia, N.H., Sept. 26, 1831" in the *American Journal of Science and Arts*, XXI (January 1832), 383.

9. Zadock Thompson, *History of Vermont, Natural, Civil and Historical* (Burlington: Chauncey Goodrich, 1842), Part III, 167.

10. *U.S. House of Representatives, 22nd Congress, 1st Session, Report on Manufactures, House Doc. #308.* (Washington: Duff Green, 1833), II, 894. This figure included the equipment of the copperas factory as well as the smelting plant.

11. Memorandum Book of Isaac Tyson Jr. in possession of Miss Rosa Tyson, South Strafford, Vt.

Boston Copper Mining Company's original Massachusetts charter which authorized the company to "hold and manage" real estate worth $100,000 and personal property worth $200,000.[12]

It quickly became clear that more technical skill was needed and in 1831 a man named Daniel Long, a native of Harford, Maryland, was employed as foreman of the smelting department.[13] The plant was expanded until in 1833 there were at least seven and possibly eight furnaces. In that year, Isaac Tyson Jr. of Baltimore was induced to become superintendent of both the copperas and copper works.[14]

Hiring Isaac Tyson was a historic step, for he was probably the leading industrial chemist of the day, certainly one of this country's pioneers in the field. He was a manufacturer of paint pigments, chemicals and medicines and was well on his way to being the major supplier of chrome to the world through his monopoly of the chrome deposits in Maryland and Pennsylvania, the most extensive known at that time.[15]

Restless, ever searching, astute, Isaac Tyson was a Quaker who shunned personal controversy and rather than dismiss an employe preferred to try to make him see the error of his way and help him correct it. Petty quarrels distressed Tyson and rather than create hard feelings he would permit his adversary to prevail if a heated artument threatened to scorch their friendship.[16] Isaac had a passion for experimenting and a shrewd business sense that enabled him to succeed despite the uncertainties and speculative nature of mining and marketing his products. He not only dominated the world chrome trade, besides investing in the Vermont copper mines, he developed an iron mine, furnace and foundry in Plymouth, Vt., invested in lead mines in New Hampshire and Vermont and owned or leased most of the copper mines of Maryland.

When Tyson arrived in South Strafford in the spring of 1833, he found eighty men at work "on the ledge." Another estimate put the top figure at 200 workers during the 1830s, testifying to the increased activity. The financial arrangements, as already described, also indicated a sizable

12. Journal of Isaac Tyson Jr., kept at South Strafford from May 6, 1833, to July 7, 1834, now in collections of Vermont Historical Society, Montpelier, Vt.; *Massachusetts Special Laws*, Vol. 7, Chapter 86, 328.

13. *United Opinion* (Bradford, Vt.), March 4, 1892, in obituary of Thomas Bond. The Longs were definitely in Strafford by August 1832, when a son was born.

14. Tyson's Journal.

15. Malcolm Van Vechten Tyson, *Genealogy of the Maryland Branch of the Tyson Family*; J.W. Stickney, "Isaac Tyson Jr. in Vermont" in *Report of the State Board of Agriculture, Manufactures and Mining, 1875–76*, 655–660; William Glenn, "Biographical Notice of James Wood Tyson," in *Transactions of the Amercian Institute of Mining Engineers*, XXXI (1902), 118–121; Guy Hubbard, "Isaac Tyson and His Iron Furnace," in *Windsor, (Vt.) Industrial History* (Windsor, Vt., Town School District, 1922), 46–53; J. Thomas Scharf, *History of Baltimore City and County*, (1881), 771–772.

16. Tyson's Journal.

undertaking. Once Tyson "drew on the treasurer for $6,700." Another time he "gave drafts" for $5,000. On numerous occasions he borrowed smaller sums to pay for needed improvements.[17]

Tyson bought property as early as 1830 in association with the Binneys in Strafford and on his own in neighboring Vershire. He later acquired other mineral properties.[18] He undoubtedly handled some of the Vermont copperas at his plant in Baltimore.[19] In 1827 he had obtained a patent for a new method of making copperas.[20]

The size and complexity of the operation at South Strafford as described by Tyson are surprising when one considers the distance of the plant from the large industrial and commercial centers of the country. Besides the furnaces and the expanding underground works, there were the cobbing house and ore crushing machine, roast beds, kilns for charcoal burning, a sulphur kiln and calciner for making Venetian red, a large dam with a water wheel to provide power for the blast and the blast machinery itself, to which Tyson added the refinement of a regulator to maintain constant air pressure.[21]

No exact description of the furnaces has been found, but some idea can be inferred from details of furnaces used in other places. They were certainly small, probably between twelve and twenty feet high with a hearth between two and four feet square. The whole structure resembled a stone chimney and may have been straight sided or tapered to smaller dimensions at the top. The tuyere projected into the hearth from the back of the furnace and the metal and slag ran out the front into clay basins. Tyson changed the size of the hearths and tuyere openings during his experiments to obtain different results. In view of the novel techniques Tyson introduced, a more detailed description would be valuable.

Tyson never stopped experimenting. Besides changing the size and shape of his furnaces, he tinkered constantly with different fuels, fluxes and ore combinations to perfect his smelting technique. Seeking better refractory materials for furnace hearths, he tested soapstone, sandstone, slate and kaolin. His sulphur kiln and calciner for Venetian red were also new wrinkles.[22]

The most important innovations were two pioneering experiments

17. *Ibid.*; the figure of 200 workers appears in William Belmont Parker, *op. cit.*, 31.
18. Land Records of Vershire, Vt., Book 11, 141, 146, 148, 170, 286, 288, 299; Strafford Land Records, Book 7, 502, Book 8, 157.
19. Author's conclusion.
20. Digest of Patents Issued by the United States from 1790 to Jan. 1, 1839. (Washington, 1840), 138.
21. Tyson's Journal.
22. *Ibid.*

commenced in early 1834. At the end of December 1833 Tyson obtained a shipment of anthracite coal by way of the Champlain Canal and wagon over the Green Mountains. In January his first attempt to smelt copper ore with anthracite coal was put under way and continued for two days.[23]

About the same time he was turning over in his mind ideas for heating the blast. This was not a new idea and Tyson undoubtedly got hints from his reading and from discussions with prominent men in the smelting business. On December 9, 1833, he wrote in the journal he kept at South Strafford that he was "fully pursuaded that heated air would be a great improvement in ore smelting." His first idea was a scheme, similar to one he had seen in Albany, New York, for conducting the hot gases from the top of the furnace to the bellows pipe, but he apparently did not adopt it.[24]

By the end of January 1834, however, Tyson had a hot blast system in operation using a heating oven of his own invention and assembled by a tinner in nearby Hanover, New Hampshire. Tyson's invention was a cast iron "cylinder," shaped like a box stove, through which the blast pipe passed. A fire kept in the cylinder heated the air as it passed through on its way to the furnace. By the time his patent was approved on April 18, 1834, Tyson had conducted extensive experiments at South Strafford and operated the mechanism successfully for short periods of time. He spread the word among his Baltimore friends, several of whom were interested and willing to give it a try in their iron furnaces.[25]

The question of how successful he was and how much copper he actually produced is unknown, but Tyson's experiments were undoubtedly the first attempts to use either anthracite coal or a hot blast to smelt copper in this country. Two authorities have testified to Tyson's pioneering efforts. William Glenn, the mining engineer who worked with Tyson's sons in later years, pointed out that Isaac was the first to erect a German blast furnace for the smelting of copper ores in this country.[26] Isaac's grandson, James W. Tyson Jr., also claimed that Isaac "was the first to successfully separate copper from pyritic ores by smelting in brick or stone-made furnaces."[27]

That Tyson was in the vanguard of a revolution in metallurgy there is no doubt. The first to use hot blast on iron was a Scotsman, James B.

23. *Ibid.*
24. *Ibid.*
25. *Ibid.*
26. William Glenn, *op. cit.*
27. Letter from James W. Tyson Jr., South Strafford, Vt., to John Spargo, Montpelier, Vt., May 2, 1930.

Neilson, who obtained a patent on his invention in 1828. Tyson's hot blast mechanism resembled Neilson's stove.

The first patent for the use of anthracite to smelt iron in this country was obtained by Dr. Frederick W. Geissenhainer of New York City.[28] His patent was approved on December 19, 1833. Geissenhainer used a hot blast but did not make any patent claim for the use of heated air.[29] His patent was approved almost simultaneously with Tyson's attempts to use anthracite on copper and his experiments with a hot blast. Geissenhainer claimed his first experiments were conducted in a small furnace in New York as early as 1831, but he did not put his method into practical use until 1836.[30]

Others were experimenting with the heating of the blast in smelting iron also, but Tyson's hot blast invention, which was designed to make more efficient use of either charcoal or anthracite, seems to have been used first by him on copper ores. Not until the end of the decade were anthracite and a hot blast successfully combined in large scale commercial iron production.[31]

Although supporting evidence is meager it is possible that Tyson's use of a hot blast to smelt copper was the first such use in the world. A hot blast, according to *The Copper Handbook* of 1911, was first used on copper in Germany in 1837 without complete success and was "utilized permanently" in Norway shortly afterwards.[32]

Isaac Tyson's journal ended abruptly in mid summer of 1834, but a memorandum book of his reveals that in August of 1834, after fifteen months in South Strafford, Tyson returned with his family to Baltimore "under the impression our scheme was a failure."[33] That these men decided to attempt smelting refractory copper ores in remote Vermont at all seems remarkable. Instead of doing what today might seem obvious—hauling the ores to Boston or Baltimore where technical facilities, fuel and other materials were more readily available—they elected to set up a mineside smelting plant, where charcoal could be easily obtained, but far from other supplies, without reliable year round transportation and with no pool of skilled workers and technicians to draw on.

Until more detailed records turn up, there is only the scantiest in-

28. James Moore Swank, *History of the Manufacture of Iron in All Ages* (Philadelphia: The Author, 1884) 267ff.
29. *Ibid.*
30. *Ibid.*
31. *Ibid.;* also William Firmstone, "Sketch of Early Anthracite Furnaces," in *Transactions of the American Institute of Mining Engineers,* III (1874-1875) 152–156.
32. *The Copper Handbook,* X (1911), 94.
33. Memorandum Book of Isaac Tyson Jr., *op. cit.*

dication of how much copper was produced during the ten year period. An 1831 report said that the ore contained about ten per cent copper (probably after it had been cobbed) and the smelting extracted "all the copper except about half per cent."[34] Tyson's journal mentions cobbing the ore to eight or nine per cent copper and smelting anywhere from 7,500 to 10,500 pounds of ore a day in one furnace. *Niles' Register* reported in March 1832 that the plant was ready to produce a half ton of copper a day.[35]

Zadock Thompson in his *History of Vermont* (1842) said that "for several years the business was carried on extensively and large quantities of copper were produced."[36] Thompson may have had as sound information as anyone because he was in possession of a description of the copper smelting works written by one of the Morrills, possibly Vermont's famous senator-to-be, Justin Smith Morrill, whose financial relations with the business were fairly close.

How, then, attribute any significance to a copper smelting operation that failed even though it was the scene of the first use of anthracite coal and a hot blast? If Isaac Tyson's career had ended at South Strafford the significance might end also, but Tyson went on to other things. Smelting and mining copper in Vermont led to similar undertakings in Maryland. In addition to his chrome properties, Tyson at one time or another controlled most of Maryland's copper deposits.

More directly significant was Tyson's use of his hot blast invention, with charcoal as a fuel, to smelt iron at Tyson Furnace in the town of Plymouth, Vermont. As early as 1833 Tyson was exploring the possibilities of iron manufacture in Plymouth. In the fall of 1837 he put his iron furnace in operation using "one of the first hot blasts for blowing a furnace in this country . . . having been cast from patterns modeled from diagrams procured by him [Tyson] in England."[37] Again, this would make him one of the first to use a hot blast in smelting iron commercially in this country, although by this time others were also using a hot blast with charcoal. His iron mine and furnace operated successfully for twenty years.

The significance doesn't end here. Daniel Long, head smelter at the pioneering copper plant in South Strafford, stayed until 1839,[38] then

34. "Copper Ore of Strafford, Vt., etc . . . . ," *op. cit.*
35. *Niles' Register*, XLII (March 31, 1832), 82.
36. Zadock Thompson, *op. cit.*, 168.
37. J. W. Stickney, *op. cit.*
38. Letter from Justin S. Morrill, Strafford, Vt., to Isaac Tyson Jr. (Plymouth, Vt.?), July 12, 1839. At this time Daniel Long was still in Strafford.

moved to Plymouth in 1840[39] where he worked until 1844. In that year he went to the Revere Copper Works[40] which was establishing a copper smelting plant at Point Shirley. It is hard to believe that Daniel Long's experience was not valuable to the Revere Copper Works, which Thomas Egleston said was "among the first American works using the continental processes successfully run in this country."[41]

In contrast to the Baltimore works, which used the English method of reverberatory furnaces, the Revere works adopted the stack, or cupola, furnaces for ore smelting. These furnaces, called the "continental type" because they followed the design of cupolas used in Germany, must have closely resembled the furnaces used at South Strafford.

It is difficult to trace all the workers, but Joseph Martin, a foreman at South Strafford, was instrumental in exploring for iron ores and setting up Tyson's iron works in Plymouth.[42] Several of the names of the miners—Chynoweth, Gundry, Bidder—at South Strafford crop up years later in neighboring Vershire at the Ely mine, which became famous in the 1870s as a boom copper camp.[43] Two of Daniel Long's sons, after learning the business at the Revere Copper Works, were largely responsible for the phenomenal success of the Ely mine. Other workers turned up in copper mines in other parts of the country. The Reynolds family's contribution was also large. They stayed on in Strafford after the Binneys and Isaac Tyson were gone, made copperas and mined or smelted copper sporadically for another seventy years. Descendants of Isaac Tyson returned to Vermont's copper range and were instrumental in developing what eventually became the state's largest producing mine.[44]

Several reasons have been given for the failure of the smelting plant at the end of the 1830s. The principal one is that the cost was greater than the income.[45] Certainly, a plausible explanation and not unusual in mining. It is probable, also, that the panic of 1837 put an unbearable strain on the undertaking. The trials and failures of later years suggest

39. In 1840 a daughter was born to the Longs at Tyson Furnace, Plymouth, according to the obituary of Eliza (Long) Johnson in the *Montpelier* [Vt.] *Argus & Patriot*, August 27, 1890.

40. *Montpelier* [Vt.] *Argus & Patriot*, Nov. 15, 1893, Obituary of Daniel F. Long, son of Daniel; *United Opinion* (Bradford, Vt.), Aug. 10, 1895, biographical sketch of William H. Long, son of Daniel.

41. Thomas Egleston, *op. cit.*, 361.

42. Tyson's Journal; J. W. Stickney, *op. cit.*

43. Tyson's Journal and Memorandum Book, payroll records of Vermont Copper Mining Co., for 1868, 1880–1882.

44. Isaac Tyson's son James Wood Tyson and his son James Wood Tyson Jr., worked the deposits spasmodically from about 1880 to 1902.

45. Zadock Thompson, *op, cit.* 168.

that the primitive techniques of the early days could not cope successfully with the South Strafford ores.

In 1833 Tyson and Binney attempted to open up the copper deposit which they had bought from a defunct local company in Vershire, the same deposit that later became the Ely mine. Tyson directed the driving of an adit aimed to tap the vein. He penetrated the hillside 94 feet and came within four of striking deposits of ore richer than those on Copperas Hills in South Strafford. But, reportedly, lack of funds and discouragement at not finding the vein, influenced his backers to abandon the work.[46]

At this same time, Doctor Binney, who had taken over the business when his father died in 1833, was on the verge of retiring with sufficient funds to nurse his declining health and pursue his hobbies. But the panic of 1837 forced him to stay at his desk for another five years until the business was pulled out of the financial morass. He finally retired in 1842, but lived only five years more. He died at forty-three in Rome on a European trip taken in an effort to regain his health.[47]

Following the panic of 1837 the corporate setup was reorganized. The Vermont Mineral Factory Company and the Green Mountain Manufacturing Company, a firm organized to exploit the copperas beds in Shrewsbury, Vermont, were merged to form the Vermont Copperas Company.[48] The Boston Copper Mining Company, incorporated in Vermont in 1833,[49] specifically to work the copper in Strafford and Vershire, remained in existence.

South Strafford's pioneer copper smelting plant was long ago relegated to obscurity, but in pursuing the subsequent history of copper mining in Vermont, one is easily convinced that Isaac Tyson's influence continued to exert itself. Except for the extraction of gold and silver, Tyson's attempts to produce sulphur, Venetian red and copper, and his weighing the possibility of making sulphuric acid and utilizing magnets to separate the iron presaged almost every later development, even to those of the World War II revival of mining on Copperas Hill, which lasted until 1958 and produced gold, silver, copper, sulphur and electrolytic iron.

46. [Roswell Farnham] "Copper Mines of Orange County" in *Gazetteer of Orange County Vt.* (Syracuse, N. Y.: Hamilton Child, 1888), 16. The financial panic in the spring of 1834 may have had something to do with the abandonment of the Vershire project. Both Boston and Baltimore were affected by the panic. Failure of the Bank of Maryland in March was a cause of considerable distress to Isaac Tyson.

47. *Introduction to the Terrestrial Air-Breathing Mollusks of the United States of America, op. cit.,*

48. *Laws of Vermont (1838)* 83. The same men owned the plants at Strafford and Shrewsbury.

49. *Ibid.*, (1833), 84.