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Joseph Wharton's Nickel Business

In the second winter of the Civil War Joseph Wharton, Philadelphia scientist and industrialist, sold his interests in the zinc industry[1] and got control of a nickel mine near a gap in the southern hills of Lancaster County. He smelted the ores on the property and within a few months acquired a refinery in Camden, New Jersey. He called the combination of mine, smelters, and refinery his "nickel business." For the next quarter of a century it comprised almost the entire nickel industry of the United States and produced at one time about one-sixth of the world supply of the metal.

The old, ore-bearing rocks, which include the Laurentian Shield in Canada, extend southward through New England and into northern New Jersey and southeastern Pennsylvania. Near Sudbury, Ontario, they contain large deposits of nickel ore. Traces of nickel have existed at many other places to the south, for example, in the Green Mountains of New Hampshire; near Chatham, Torrington, and Litchfield, Connecticut; and at Lowell, Massachusetts. Everywhere that they occur in these ancient rocks the ores of nickel belong to a classification called nickeliferous pyrrhotite and chalco-

1 W. Ross Yates, "Samuel Wetherill, Joseph Wharton, and the Founding of the American Zinc Industry," *The Pennsylvania Magazine of History and Biography*, XCVIII (1974), 469–514.

pyrite, also styled sulphide ores because of the large amount of sulphur which must be driven off before they can be refined. Nickeliferous pyrrhotite and chalcopyrite contain a variety of mineral forms and include not only nickel but also iron, copper, usually cobalt and small amounts of other metals and minerals. By 1863 the ore bodies near Chatham and Lowell and in the Lancaster hills had been found and worked, principally for copper. (Some old maps refer to the Lancaster hills as "coppermine ridge.") Several nickel deposits had been discovered in other parts of the United States, the most noted being at Mine La Motte in Missouri, which was mainly a lead mine. Though not plentiful in the earth's crust, and never occurring in a pure form, nickel was not considered a scarce metal. Many years later scientists judged it to be one of the common elements in the earth's core and in the cosmos.[2]

According to tradition, the deposits in Lancaster County had been mined off and on for copper since 1718. That was well before nickel was identified as a separate element. The Swedish scientist Axel Frederik Cronstedt first listed nickel among the metals in 1751 and three years later named it from *Kupfernikkel,* an alloy or impure grade of copper sometimes obtained from a species of ore called by the same name. *Nikkel* in the word *Kupfernikkel* was a pejorative term, which could be translated as meaning "false." The true

2 Good general accounts of the rise and progress of the nickel industry and of the metallurgy of nickel can be found in F. B. Howard-White, *Nickel, An Historical Review* (New York, 1963), especially 15–49; Joseph R. Boldt, Jr., *The Winning of Nickel* (New York, 1967), especially 1–15, 83–87, 191–339. Some informative accounts which appeared at the time Wharton was engaged in the nickel business include: "Nickel," *The American Cyclopaedia* (New York, 1875), XII, 431–433; Francis L. Sperry, "Nickel and Nickel-Steel," *Transactions, American Institute of Mining Engineers* [hereinafter *Transactions, AIME*], XXV (1895), 51–55; Stephen H. Emmens, "Geological Distribution of the Useful Metals in the United States," *Transactions, AIME,* XXII (1893), 53–95; Stephen H. Emmens, "The Metallurgy of Nickel," *The Mineral Industry, Its Statistics, Technology and Trade in the United States and Other Countries,* edited by P. Rothwell as a statistical supplement of the *Engineering and Mining Journal* (New York, 1893), 352–356; Walter R. Ingalls, "Nickel and Cobalt," *ibid.,* 343–351; W. P. Blake, "Nickel," in Albert Williams, Jr. (ed.), *Mineral Resources of the United States, 1882,* a Report of the Department of the Interior, U.S. Geological Survey (Washington, D. C., 1883), 399–420; W. P. Blake, "The Metallurgy of Nickel in the United States," *Transactions, AIME,* XI (1882–1883), 274–281; Lewis Feuchtwanger, "Nickel and Its Uses in the Arts," *Journal of the Franklin Institute* [hereinafter *JFI*], XCVI (1873), 136–140, 204–213. The term "Coppermine Ridge" appeared for example in Henry F. Walling and O. W. Gray, in *New Topographical Atlas of the State of Pennsylvania* (Philadelphia, 1872), 80.

characteristics of nickel remained unknown for a long time. The metal was first refined as a by-product of copper and cobalt—the latter being prized for the pure blue color it imparted to glass and to porcelain glazes. To be sure, Cronstedt's discovery of nickel as a component of *Kupfernikkel* amounted to recognition of an alloy which had been around for some time and was better known to the English by the name of German silver, although even in English it had many other names. This alloy had been introduced into Europe from China, where it had been used for several centuries and was called packfong and by similar names. The alloy consisted of two parts copper and one part each of nickel and zinc, more or less; the actual composition varied considerably from one manufacturer to another, and it also contained the impurities of the ores from which it was produced. German or nickel silver had the color of silver and was less corrosible. It became popular as a substitute for silver in making cutlery.

Pure nickel then had no uses. By the time Wharton bought the Gap Mine—as the mine in the Lancaster hills was called—few scientists or manufacturers had seen it. "Commercial nickel is a very impure article, and bears no more relation to pure nickel than brass or bell-metal does to copper," wrote a scientist in 1863, who went on to point out that the commercial nickel on the market was produced principally in England, France, and Prussia and contained from 76 to 86 percent nickel, the rest being cobalt, copper, iron, arsenic together with traces of zinc, manganese, sulphur, carbon, silica and alumina.[3] By 1863 no strategic uses for nickel or nickel alloys had yet been found, although some scientists hoped that the metal might yet be used to improve the iron employed in making armaments. Nickel was known to be in meteorites, which were basically nickel-iron alloys; and some meteorites had the hardness and resistance to corrosion desired for ordnance and armor. Nevertheless, by the beginning of the Civil War attempts at producing such nickel-iron alloys in the laboratory had failed. The English chemist William S. Fairbairn had reported the unsuccessful results of his own experiments and had added that "During the last two

[3] Lewis Thompson, "On the Manufacture of Nickel," *JFI*, LXXV (1863), 355. See also A. R. Roessler, "Nickel Linnaeite," *JFI*, LXXXIX (January-June, 1870), 85.

years, innumerable experiments have been made" for the purpose of producing a metal suitable for the casting of cannon and heavy ordnance, "but the ultimate result appears to be that . . . there is no metal so well calculated to resist the explosion of gunpowder, as a perfectly homogeneous mass of the best and purest cast iron, when freed from sulphur and phosphorous."[4]

Nickel ores were exceptionally hard to refine. "The separation of it from its ores is a complicated and difficult process, of which many of the details are kept secret by manufacturers," wrote J. D. Whitney in *The Metallic Wealth of the United States*, published in 1854.[5] Nickel had an exceedingly high melting point (1453° C.) and possessed many of the properties of iron, from which it could be separated only with difficulty. The European manufacturers, who also had nickeliferous pyrrhotite to deal with, began the process by roasting the ores, that is, burning them in blast furnaces to eliminate much of the sulphur and waste material. The product of the furnaces was called matte, a concentrate containing all of the metals and the remaining waste. The prevailing approach to refining matte copied that then used for extracting copper. The matte was subjected to a series of reactions with various reagents to selectively leach out the metals. Much later this method was referred to as a "wet process" to distinguish it from newer methods in which liquid reagents were used far less often. The cost of the wet process helped to keep the price up and correspondingly discouraged attempts to find other ways to employ the metal. At a time when great strides forward were being made in an understanding of the metallurgy of iron, copper, lead, gold and some other metals that of nickel was being neglected. John Percy's pioneer text on metallurgy, published in 1861, contains sections on fuel, fire clays, copper, lead, zinc and some other metals, but none on nickel; and cobalt is dealt with only in connection with separating it from copper in the refining of copper ores.[6]

4 William S. Fairbairn, "Experiments to Determine the Properties of Some Mixtures of Cast Iron and Nickel," *JFI*, LXXII (1861), 97.

5 (Philadelphia, 1854), 496.

6 *Fuel; Fire-Clays; Copper; Zinc; Brass, Etc.* (London, 1861). The sixth edition of Frederick Overman's *A Treatise on Metallurgy* (New York, 1868), 624–630, gave seven pages to a general description of the wet process for refining nickel.

Nickel in paying quantities was found in the Lancaster hills in the winter of 1852–1853. The general disinterest in the metal may have accounted for the failure to discover it earlier; but also, the principal deposit began about sixty feet below the surface of the ground. Before 1849 the companies which from time to time had mined for copper had been confined largely to surface operations. A shaft had been sunk to a depth of from sixty to eighty feet, but water had proved to be too great an impediment for the primitive pumps to cope with.[7] In 1849 another group began working the deposit for copper. Two years later Henry Kinzer, Lewis Cooper, John Fausset and E. F. Witmer received a charter incorporating the Gap Mining Company, capital stock not to exceed $120,000, "to mine and excavate for copper, lead, and other ores and metals; and the same to stamp, crush, and otherwise prepare for market."[8] The shaft was sunk deeper, and the refuse was piled nearby. Someone (in 1877 Charles Doble, then mine superintendent, claimed the honor for himself) suspected the refuse might contain something of value. It was analyzed by a Philadelphia chemist, F. A. Genth, and found to contain between 1½ and 3 percent nickel. So the company began to give attention to that metal. Another company erected smelters to the north of the mine, which the Gap Mining Company bought a few years later. In 1853 F. M. Buck, E. W. Coffin, and others built a small refinery at Camden to which the matte from the Gap Mine was sent.[9] By 1854 several scientific journals had published descriptions of the mine and its ores.[10] Still, the operation did not pay expenses. By 1860 the Gap Mining Company had

7 "A Visit to the Gap Mine of Lancaster County, Pennsylvania" (reprinted from *JFI*), *The Mining Magazine* (New York, January-June, 1854), II, 321. The best descriptions of the Gap ores are: Persifor Frazer, Jr., *The Geology of Lancaster County, Second Geological Survey of Pennsylvania: Report of Progress in 1877* (Harrisburg, 1880), 78–80; "Lancaster County Nickel Mines," *Annual Report of the Secretary of Internal Affairs of the Commonwealth of Pennsylvania, 1874–1875, Part III, Industrial Statistics* (Harrisburg, 1876), 348–352; J. F. Kemp, "The Nickel Mine at Lancaster Gap, Pennsylvania, and the Pyrrhotite Deposits at Anthony's Nose, on the Hudson," *Transactions, AIME*, XXIV (February-October, 1894), 620–633. The latter two rely heavily on a report prepared by Charles Doble, Superintendent of the Gap Mine. The report contains some minor errors.

8 Act No. 236, Approved Apr. 18, 1851, *Laws of the General Assembly of the Commonwealth of Pennsylvania, Session of 1851*, 369–371.

9 W. P. Blake, "Nickel," 405.

stopped work, and the mining machinery and smelters were falling into disrepair.

That was still the situation in late 1862 when Wharton bought $1,000 worth of Gap Mining Company stock.[11] A few weeks later, in January 1863, he purchased a controlling interest in the company and leased all of its properties for a term of ninety-nine years. The company made him a special monetary allowance for "the bad condition of mine buildings, machinery, etc."[12] Doble, hired as superintendent, directed the work of pumping water out of the mine and repairing the machinery and smelters. Within a few months the mine was in working order. On May 13, 1863, Wharton leased the idle nickel refinery in Camden and began renovating it. That was to take longer as it involved determining and applying an efficient process for refining the Gap ores. Until he could do this he sold the matte to European refiners. The first such shipment, to Evans and Askin of Birmingham, England, was recorded December 10, 1863. That firm continued to receive matte from Wharton; and on September 27, 1865, the first sale destined for Fleitmann and Witte of Iserlohn, Prussia, was made.[13] Sales of nickel from the

10 "A Visit to the Gap Mine of Lancaster County, Pennsylvania," 321–322.

11 Balance Sheet of Dec. 31, 1862, in Gap Journal, Box 26, Wharton Papers [hereinafter WP], Friends Library, Swarthmore College.

During much of the period of his nickel business Wharton kept three sets of ledgers with financial information pertaining to that investment, namely: (1) separate ledgers for the Gap Mining Company and the refinery at Camden (the ledgers for the mining company are variously entitled Gap Journal and Gap Establishment; those for the refining works are entitled Camden Ledger or American Nickel Works); (2) a set of ledgers combining much of the information in the mining and refinery ledgers, entitled from 1863 to 1868 Journal, Joseph Wharton, and after that, Nickel Business; (3) an account of income, expenditures, etc. for all of his various enterprises, called Private Accounts, Joseph Wharton (1869–1875) and Ledger, Private Accts. (1876–1884, 1885–1898). These ledgers contain not only important financial data (which can sometimes be cross-checked from one ledger to another) but also comments in Wharton's handwriting.

12 Entry of Jan. 12, 1863, Gap Journal, Box 26, WP. The entry includes a lengthy note giving details of the transaction. Wharton bought 15,100 shares at $1.50 per share for a total sum of $22,650, which, after the allowance was made, represented a payment of $16,850. The lease was to run from Jan. 1, 1863. The entry for Jan. 12, 1863, in Journal, Joseph Wharton, Box 25, WP, also records the transaction and indicates the purchase was made from William Coffin.

13 Gap Journal, Box 26, WP.

Camden refinery to domestic German silver makers began September 25, 1865.[14]

Why did Wharton undertake this highly risky venture in nickel? The extent of the deposits at the Gap Mine were unknown; the processes needed for refining them at a commercially advantageous cost had not been worked out; nickel was not a glamorous metal and had no known strategic uses; a few mines and refineries in Europe were supplying all of the nickel which the market could absorb. There had not yet been a successful nickel business in North America, although several companies had made attempts. Furthermore, in those war years there were many other opportunities for investment by which Wharton might have expected to increase his fortune more surely than by gambling in nickel.

Part of the answer can be gained by inference from his way of life. Born into a respected Quaker family of Philadelphia, he was first concerned with the claims of family and city. Entrepreneurs such as John D. Rockefeller and Andrew Carnegie might take up one line—oil or steel—and follow it wherever it led. Wharton chose not to remove from the place of his birth. He never made an investment which required an extensive residence away from Philadelphia. Even when he was building up the zinc industry in South Bethlehem he acquired no real estate there for his personal use. He lived in a hotel when it was necessary to spend the night near the zinc works. He had established a foreign market for zinc oxide largely through the work of his brother Charles, who went to England and the continent for that purpose. Joseph Wharton made his first trip to Europe in 1873, when he received a presidential appointment as commissioner to the International Exhibition at Vienna.[15]

Also, he was a scientist. Making money in itself did not satisfy him, and he never undertook a major business venture that did not present some scientific or engineering challenges. Even when he was heavily involved in a standard industry, such as that of iron and steel, he gave his principal attention to the areas in which science and engineering might accomplish something new, profitable, and

14 Camden Ledger, Box 26, WP.

15 Paper of Appointment of Joseph Wharton as Commissioner to the International Exhibition at Vienna, Austria, May 1-Oct. 31, 1873, signed by Hamilton Fish, Box 31, WP.

personally satisfying. He published an impressive number of scientific papers, not only on the chemistry of various metals but also on such far-ranging subjects as the pigment in autumn leaves and the fall-out from the explosion of the volcano Krakatoa.[16]

The nickel business fitted these interests. The Gap Mine was about fifty miles distant from Philadelphia; the refinery was across the Delaware. The challenges to improve the processes for refining the metal, making pure, malleable nickel and discovering strategic uses for the metal were certainly there.

Wharton had no use for wartime profiteering. Much of the money he made from the sale of his zinc business went temporarily into government bonds to support the Union cause. At the same time, he increased his investment in the Bethlehem Iron Company, which had just put its first furnace into blast in South Bethlehem. He became a director of the company in 1863.[17] The nickel mine was then available for purchase. Wharton probably already knew as much about the ore deposit there and the metallurgy of nickel as anybody in the United States. He read French and German in which much of the literature on nickel and zinc was published; and in those pioneer days of metallurgy this literarure was not so extensive but that one person could read it in his spare time. It seems safe to assume that Wharton knew Professor Genth and the principal owners of the mine and the refinery. Also, and perhaps most importantly, Wharton was a good friend of James Curtis Booth, a Philadelphia chemist who in 1836 was appointed Professor of Applied Chemistry at the Franklin Institute, where he lectured for nine years. Booth had on one occasion served as Wharton's representative in a dispute with the Lehigh Zinc Company. He had for years experimented with nickel and cobalt and their ores. He had studied the various known deposits in the United States and in

16 For example: Joseph Wharton, "Speculations upon a Possible Method of Estimating the Distance of Certain Variably Colored Stars," *American Journal of Science and Arts* (New Haven, July-November, 1865), XC, 190–192; Joseph Wharton, "Observations upon Autumnal Foliage," *ibid.* (January-May, 1869), XCII, 251–255; Joseph Wharton, "Dust From the Krakatoa Eruption of 1883," *Proceedings, American Philosophical Society* (Philadelphia, 150th Anniversary Meeting, May 22–26, 1893), 343–345, reprinted in *Science* (New York, Feb. 2, 1894), XXIII, 57–58.

17 Meeting of July 28, 1863, Minutes of the Board of Directors, Bethlehem Iron Company, Schwab Memorial Library, Bethlehem Steel Corporation, Bethlehem, Pa.

1845 had engaged in mining cobalt at Mine La Motte. In 1849 Booth had been appointed smelter and refiner of the mint at Philadelphia, the only United States mint making small coins, and he held the position up to the time of his death in 1888.[18] Following some successful experiments by Booth in the 1850s, Congress authorized the use of a nickel-copper alloy in making the one-cent piece, thus opening a new—and domestic—market for nickel. This, indeed, was the reason Wharton publicly gave for entering the nickel business: The Director of the mint (then James Pollock) urged him to do so to help supply the nickel for making one-cent coins, "since the American attempts to produce that metal had broken down, and in no foreign country could an adequate supply be purchased."[19]

Wharton's entry into the nickel business thus coincided with the first regular issuance by the United States government of a nickel-alloy coin. An interest in nickel for the purpose of making small change had been stimulated by an increase in the number of petty business transactions that had produced a demand for small coins. People then generally believed that all metallic money should have an intrinsic value equal to its face value, that is, a penny should contain a pennyworth of metal. Silver had been used but was too dear and made coins of an undesirably small size. Individuals and governments began looking at less expensive metals such as copper—which had actually been used for some time—and alloys, including combinations with nickel. In the depression of 1837 an American chemist named Lewis Feuchtwanger issued 1,500,000 German silver cents on his own initiative and unsuccessfully tried to persuade Congress and the mint to begin a regular coinage of nickel-alloy cents. A federal law of Switzerland of 1850 provided for small coins containing a very small fraction of silver and an alloy of copper, zinc, and nickel.[20] In 1853 Booth produced an experimental cent of

18 *The National Cyclopaedia of American Biography* (New York, 1906), XIII, 245–246.

19 Joseph Wharton, letter to the editor of *Lock and Bell* (New York and Philadelphia, June, 1888), I, 2, 9. And see Joseph Wharton, *Suggestions Concerning the Small Money of the United States* (Philadelphia, 1868), 25.

20 Lewis Feuchtwanger, 204; Joseph Wharton, *Memorandum Concerning Small Money and Nickel Alloy Coinage: With Illustrations and Descriptions of Existing Nickel Alloy Coins* (Washington, D. C., 1877), 38, 39 [hereinafter *Memorandum Concerning Small Money*].

60 percent nickel and 40 percent copper. Two years later the Philadelphia mint began regular coinage of a one-cent piece of 12 percent nickel and 88 percent copper, although the law authorizing the circulation of this coin was not approved until February 21, 1857.[21] In 1860 Belgium began a coinage of five-, ten-, and twenty-centime pieces using an alloy of 75 percent copper and 25 percent nickel.[22]

In the United States the "nickel cent" was immediately popular. The mint could not keep up with the demand. When the Civil War broke out, and the need for small money increased still further, Secretary of the Treasury Samuel P. Chase ordered issues of three-cent bank notes.[23] Since coins were more desirable, people began hoarding them. The experience convinced officials at the mint that an intrinsic value was nonessential for small coins. A token value, backed by a promise of redemption in money composed of metal having an intrinsic value (gold or silver), would suffice.

This conviction was behind a recommendation from Pollock in mid-1863 that Congress authorize replacement of the nickel-copper alloy, which was expensive, by a cheaper bronze, composed of 95 percent copper and the rest, tin and zinc, for the one-cent piece. His annual report for the fiscal year ending June 30, 1863, gave the case against nickel. The supply, Pollock wrote, had to be purchased abroad for two dollars per pound. Such an expenditure for nickel was wasteful. "We have given it away, under the mistaken notion that value was essential to secure the circulation of our inferior coinage, and to prevent its being counterfeited." He continued, "Nickel derives its name from a certain unpleasant allusion, indicating its character, and which, in a metallurgic sense, it honestly deserves. It is very obstinate in the melting pot, requiring the fiercest fire even when in alloy with copper. It commonly makes a hard mixture, very destructive to dies, and all the contiguous parts of the coining machinery. Perhaps as great an objection as any to the further use of this alloy is its limited use in the arts. With the

21 James R. Snowden, *A Description of Ancient and Modern Coins in the Cabinet Collection at the Mint of the United States* (Philadelphia, 1860), 119–120.

22 Joseph Wharton, *Memorandum Concerning Small Money*, 37–38.

23 R. S. Yeoman, *A Guide Book of United States Coins*, 27th rev. ed. (Racine, Wisc., 1974), 10. See Lewis Feuchtwanger, 204, for a contrary judgment concerning the popular reception of the "nickel cent."

addition of zinc it would make good German silver, and could be worked up into plated ware. Beyond this, and a few other applications, copper with 12 per cent of nickel is of no more value to the artizan [*sic*] than copper alone; it is even a deterioration, as it is more difficult to melt." Aluminum was being experimented with and was held to have much promise for small coins, although it was still too costly for use. Pollock's report contained only two sentences which Wharton could have found at all encouraging, namely: "An effort is now making to re-establish in our country the manufacture of nickel from native ores. If successful, as present appearances indicate it will be, the Mint may be supplied from this source, to the entire exclusion of the foreign article."[24]

Congress accepted Pollock's recommendation to exchange bronze for nickel-copper alloy in the one-cent piece. His annual report for the fiscal year 1864 noted that the new bronze alloy was highly successful; that the demand for one- and two-cent pieces was further increasing; and that people were still hoarding them. His report also indicated that experiments using aluminum were continuing, but that so far no satisfactory alloy had been found.[25]

Wharton's books show that in 1864 he sold only 2,936 pounds of nickel to the United States mint, all of which had been refined by Evans and Askin from matte produced at the Gap Mine.[26] Clearly, if the mint were to be retained as a steady customer, the decision of Congress against the use of nickel in small coins would have to be reversed; and to make nickel acceptable to the mint, the metal would have to be more malleable and the price would have to come down. In addition, because Congress required the mint to buy in a competitive market, Wharton would have to reduce his own costs of operation and work for an increase in the tariff.

Getting Congress to change its mind concerning nickel coinage was not difficult. The shortage of small coins and the relative unpopularity of the three-cent pieces of paper prepared the way. According to one authority, "The nickel interests seized upon this

24 *Annual Report of the Director of the Mint for the Fiscal Year Ending June 30, 1863* (Washington, D. C.), 8.

25 *Annual Report of the Director of the Mint for the Fiscal Year Ending June 30, 1864* (Washington, D. C.), 9–11.

26 "Acct. of Sales of Nickel to U.S. Mint," Box 24, WP; Gap Journal, Box 26, WP.

circumstance to fight for a new three-cent coin for redemption of the paper money. A law was quickly passed and signed by the president as of March 3, 1865, providing for a three-cent coin of 75–25 copper-nickel composition."[27] The records are silent concerning Wharton's part in the matter. However, as he was the only refiner of nickel in the United States, "nickel interests" probably referred principally to him. One may imagine him in touch with his friend and fellow protectionist Congressman E. J. Morris of Philadelphia to have the necessary legislation expedited. In any event, the law was passed. Also, the following year, on May 16, 1866, a five-cent piece of 75–25 copper-nickel alloy was authorized. Thus the nickel, as the coin soon became known, was brought into being.

These actions essentially fixed the nickel-copper alloy coinage of the United States for the duration of Wharton's activity in mining nickel ore. No further change occurred until 1890, when Congress ordered discontinuation of the three-cent piece entirely.[28] To be sure, other propositions were made. Various alloys were experimented with as potential substitutes, so that a possibility of change in the nickel-alloy coinage was almost always present. Wharton's characteristic response to this danger to his interests was that of publicizing the advantages of nickel for coins from a scientific point of view. As early as 1864 he published a twenty-four page pamphlet entitled *Project for Reorganizing the Small Coinage of the United States of America, by the Establishment of a System of Coin Tokens, Made of Nickel and Copper Alloy*. He revised and enlarged this work in 1868. Eight years later he rewrote it as a short treatise, which he revised in 1877 and published under the title *Memorandum Concerning Small Money and Nickel Alloy Coinage: With Illustrations and Descriptions of Existing Nickel Alloy Coins*.[29]

The issuance of token small change put the Philadelphia mint into a profitable business, as the value of the small change issued was much greater than were the costs of coinage and distribution.

27 R. S. Yeoman, 10.

28 Joseph Wharton, *Memorandum Concerning Small Money*, 33–37; *Instructions and Regulations in Relation to the Transaction of Business at the Mints and Assay Offices of the United States, together with Coinage Laws* (Washington, D. C., 1888); David K. Watson, *History of American Coinage* (New York, 1899, reprinted 1970), 220.

29 The first three were privately published in Philadelphia. The pamphlet of 1877 was published by the Government Printing Office, Washington, D. C.

Congress ordered the mint to keep a separate account of these profits, which were annually turned over to the United States Treasury. In years of prosperity, when large amounts of small coins were issued and reissued, the profits were considerable, for example, more than $1,000,000 each in fiscal 1867 and 1868.[30]

Wharton considered the immediate task to be that of making his nickel business the best in the world. He had an advantage in the purity of the Gap ores, which contained no arsenic and few or insignificant amounts of some other elements commonly found in nickel ores and capable of impairing the quality of the refined metal.[31] He needed the best advice available for developing and applying a suitable process. As the nickel which he sold to the mint had been refined by several European manufacturers, he inquired of officials at the mint concerning which in their experience produced the most suitable nickel for coinage. He was told that the Prussian firm of Fleitmann & Witte made the best. Wharton got in touch with Dr. Theodor Fleitmann, managing partner of the firm, who, as Wharton narrated the story, "in the spring of 1866 came to this country and remodelled my refining works, which have since been conducted under his guidance for the account of our firm Wharton & Fleitmann."[32]

The arrangement was to be as follows: Wharton and Fleitmann would form a partnership, effective May 1, 1866, each contributing $25,000 of capital and agreeing to share equally in the profits. The firm of Wharton and Fleitmann would lease the Camden works and obtain matte from the Gap Mine. Fleitmann would be in charge of the Camden refinery, operating it through a chemist of his employ, although Fleitmann himself would spend at least four weeks a year at Camden. Fleitmann would also advise concerning the opera-

30 Annual reports of the Director of the Mint, 1869, 1871–1896. These were in some years published as separate pamphlets and in other years were included in the Annual Report of the Secretary of the Treasury (see note 56). The *Annual Report of the Director of the Mint*, 65, for the fiscal year ending June 30, 1873, contains a summary of the yearly profits of small coinage from fiscal 1857 to fiscal 1872.

31 Tests made by William E. Gard and described in "Contributions from the Sheffield Laboratory of Yale College, No. L," reprinted in "Analyses of Cast Nickel, and Experiments on the Combining of Carbon and Silicon with Nickel," *The American Journal of Science and Arts* (New Haven, Conn., July-December, 1876), CXIV, 274–276.

32 Joseph Wharton, *Suggestions Concerning the Small Money of the United States*, 26.

tion of the Gap Mine. Foreign sales would be handled exclusively by Theodor Fleitmann's brother Hermann of New York, who would receive a commission of 2½ percent on nickel and 2 percent on matte.[33]

The agreement was made. Fleitmann hired Oscar D. Allen, a chemist already in Wharton's employ at Camden, "to superintend, manage and direct the chemical and manufacturing operations of said works" for an annual salary of $1,500 and a percentage of the profits—3 percent for the first year, 4 percent for the second year, and 6 percent for the third and subsequent years. Allen agreed not to disclose any of the secrets of manufacture.[34]

The work of renovation took approximately twenty-eight months. In early July 1868 the refinery burned but was speedily rebuilt, with brick and stone walls replacing the original wooden ones.[35] The partnership was apparently satisfactory to both Wharton and Fleitmann, and they remained friends after it was dissolved. That occurred August 12, 1868, when Wharton bought out Fleitmann for $76,635.12 and for another $56,153.49 purchased the firm's assets.[36] Fleitmann's work involved improving the standard wet process, which all manufacturers then used, instead of inventing any new ones. The advances in the metallurgy of nickel for which he later gained some fame were made subsequent to his work with Wharton.[37] By the fall of 1868 Wharton's nickel business was fully organized and was operating in the manner which characterized it for the next twenty years. As he boasted in February, "The result of the five years toil . . . and of the outlay of a large amount of money (in the aggregate about $300,000), is . . . an establishment of mine, smelting works, and refinery, complete in one ownership, producing the best

33 There are several memoranda in Box 24, WP, concerning the agreement between Wharton and Fleitmann. That between the firm of Wharton and Fleitmann on the one hand and Hermann Fleitmann of New York is in Box 31, WP.

34 Box 31, WP. Allen may have been Wharton's original contact with Fleitmann. Allen went to Europe for Wharton a few months before the agreement with Fleitmann was reached. See a statement signed by Oscar D. Allen, Oct. 20, 1865, *ibid.*

35 Entry of Dec. 31, 1869, Nickel Business, Box 28, WP. A letter from Robert Haydock to Wharton, July 15, 1868, also refers to the fire. Box 20, WP.

36 Entry for Aug. 12, 1868, Journal, Joseph Wharton, Box 27, WP.

37 Joseph Wharton, "The Production of Nickel and Cobalt in 1896," *Annual Report of the U.S. Geological Survey, 1896–97, Part V—Mineral Resources of the U.S.* (Washington, D. C., 1897), 7, 12, 15; W. P. Blake, "Nickel," 419.

nickel in the world, and second in magnitude to only one other; that of a wealthy and respectable English firm."[38]

What was the general nature of Wharton's nickel business at this time and during the subsequent years of its greatest productivity? The mine and smelters were located on a property of about 450 acres, which also contained a small company town and much farm land.[39] Charles Doble in 1877 described the mine as opening out on the vein of nickel ore "in length by shafts and tunnels about 2,000 feet, and the deepest point attained is 235 feet. There are 6 shafts ranging from 100 feet to 235 feet deep, and a few others from 60 feet to 80 feet deep. All the shafts are vertical. The ore is rarely found in paying quantities nearer than 50 or 60 feet to the surface. There are 2 steam engines at the mines, one a low pressure Cornish pumping engine, 100 horse power, for pumping the water out of the mines, and the other a 25 horse power, high pressure, for hoisting the ore and rubbish out of the mines." When in full operation the mine employed about seventy-five men and twenty-five boys, the latter being used primarily to pick waste rock out of the ore before it was sent to the smelters, which were located about three-quarters of a mile north of the mine. Of the smelting works Doble wrote, "There are two 25 horse-power steam engines at the smelting works. One drives the blast cylinders which give blast to the furnaces, and the other drives the rock breaker and Cornish crusher. There are three blast furnaces, but only two in blast at a time. There are also there a cooper shop, a blacksmith shop and a wagonmaker shop." The smelters employed another fifty persons. Daily wages in 1877 varied from ninety cents a day for unskilled labor to a range of, for miners, $1.10 to $1.40 and, for engineers and

[38] Joseph Wharton, *Suggestions Concerning the Small Money of the United States*, 26–27.

[39] The two most extensive descriptions of the Gap Mine and property, from which the material here is taken, are that given by Charles Doble in Persifor Frazer, Jr., 163–176, and a questionnaire filled out in Wharton's handwriting, entitled "Information for the Jury, Universal Exposition of 1878 at Paris," Box 24, WP. Two pictures of the Gap Mine, taken in 1894, and a diagram of the ore deposit can be found in J. F. Kemp, "The Nickel Mine at Lancaster Gap, Pennsylvania, and the Pyrrhotite Deposits at Anthony's Nose, on the Hudson," 624 and opposite 632. A detailed map (330′ = 1″), entitled "Plan of Joseph Wharton's Gap Nickel Mine and Furnace Tracts in Lancaster Co., Pa., from the original map made by W. M. Cooper, 1872," is contained in *Lancaster County Maps, Second Geological Survey of Pennsylvania.*

mechanics, $1.50 to $1.80 per day. The fuel used at the mine, smelters, and refinery was anthracite and bituminous coal and coke from Pennsylvania mines.

The matte was packed in casks and shipped over the Pennsylvania Railroad to docks in Philadelphia, from whence it was loaded on ships or barges and carried across the Delaware and several hundred yards up the tributary known as Cooper Creek (now Cooper River) to a small wharf on the property of the refinery. This property of about three acres lay between Cooper Creek and Tenth street and between York and State. The refinery was housed in several unimposing buildings, including, at the very least, a main building, one for making pure nickel, a blue vitriol house, stables and a blacksmith's shop. The works were run by two steam engines of one hundred horse power. For a time a small glass works owned by Wharton occupied a structure adjoining the nickel refinery.[40] The refining process was by contemporary standards almost unbelievably crude. The principal equipment consisted of vats, tubs, filters, steam tubes, and carboys for holding reagents, etc. Wheelbarrows provided the principal means for carrying solids from one place to another. Reagents were added to the solutions by pitcher or bucket. Filtering relied on gravity alone. At one point in the process, as Wharton described it, the workman determined when a solution had reached the proper temperature by dipping his fingers into the vat. Smells of sulphur and chlorine pervaded the atmosphere. At one stage of the process an excess of chlorine gas was expelled into the outside air through a stack.[41]

Small and primitive though this nickel business was by comparison with its counterparts in the twentieth century, it was for most of the period of its operation the nickel industry of the United States. The small amounts of matte occasionally produced at Mine La Motte and other places were shipped to foreign refiners. Until the Orford Copper Company began operating in the late 1880s no other regularly working nickel refinery existed within the country.

40 "Information for the Jury, Universal Exposition of 1878 at Paris," Box 24, WP; entries concerning payments to the Pennsylvania Railroad, Joseph Wharton, Journal, Box 26, WP; various entries in Nickel Business, Box 28, WP; Ledger, Private Accts., Box 30, WP.

41 Ms. in Wharton's handwriting describing the processes used at the American Nickel Works in 1874, Box 24, WP.

The principal products of Wharton's nickel business were nickel, cobalt oxide, and blue vitriol (copper sulphate), with nickel salts and copperas (ferrous sulphate) figuring in the sales in some years. Nickel salts were used for nickel plating. Copperas was used in the arts for dyeing black and making black ink. Blue vitriol was employed for destroying a fungus of wheat called smut and, at the time of Wharton's nickel business, for countering the deadly phylloxera in the vineyards of France and other countries. In giving the extent and value of annual production in 1878 Wharton wrote, "Nickel . . . say 200,000 lbs. annually; annual value hitherto about $2.00 per lb.; at present but little over $1.00 per lb. Cobalt oxide about 6,000 to 8,000 lbs. annually value about $4 per lb. Blue vitriol about 400,000 lbs. annually—annual value about 10 cts. per lb. at present about 7c per lb. Other products variable and not important."[42] In other words, in terms of weight and bulk, the copper by-product called blue vitriol led the list, although nickel in its various forms accounted for about 90 percent of the income. In the thirty years from 1869 to 1899 nickel, cobalt oxide, and blue vitriol were marketed every year. Nickel salts were sold for the first time in 1870 and in the years from 1872 to 1880 inclusive. Copperas was marketed between 1869 and 1873 and again in the period from 1886 to 1898 inclusive. The relative value of these various products for selected years gives a fair indication of their continuing share of total sales throughout the thirty-year period.

Percent of Value of Total Product
of the Several Products of the
American Nickel Works[43]

Year	*Nickel*	*Cobalt Oxide*	*Nickel Salts*	*Blue Vitriol*	*Copperas*
1870	85%	4%	5%	5%	1%
1875	90	3	2	5	—
1880	90	4	*	6	—
1885	85	8	—	7	—

* less than one percent

[42] "Information for the Jury, Universal Exposition of 1878 at Paris," Box 24, WP.

[43] Percentages are figured from dollar amounts given in American Nickel Works, Box 28, WP.

As to its legal form, Wharton's nickel business was privately and individually owned. Less than a year after leasing the refinery at Camden Wharton bought it outright and later renamed it "American Nickel Works." Following his initial purchase of a controlling share in the Gap Mining Company he continued to buy its stock until, by the end of 1868, he owned almost all of it.[44] A letterhead for 1885 indicates that the operation was then formally styled, "Gap Nickel Mines and Furnaces."[45] The whole operation was unencumbered by obligations or debts in the form of stock, bonds, bank loans or mortgages. Wharton took all the profits for himself and supplied any deficit from the earnings of his other enterprises.

The years from 1863 to 1869 were, as Wharton later stressed, "lean," and his financial records bear this out. In 1865 he produced more nickel than he could sell and lost heavily. His profits in the other years were small. His entry into the business increased the world supply of nickel and the price dropped from approximately $2.00 a pound in 1863 to about $1.25 in 1870.[46] Wharton charged that the price of nickel had also been depressed as a result of "the English policy of screwing down the price of everything they buy from other countries" (including matte from the United States) in an attempt to force him out of business.[47] The tariff on nickel was then fifteen cents a pound, much too low, Wharton argued, to protect him from the English price cutting. Before his Camden refinery was fully operating, a low tariff had allowed him to make a "slight profit" on the nickel which the European refiners extracted from his matte and shipped back to him.[48] But after the American

[44] See note 12. In July and August 1864 Wharton paid $1.30 per share; $1.05 each for 1,000 shares bought in February 1865; $1.00 per share for 350 shares purchased in June 1865. Gap Journal, Box 26, WP. An entry for Dec. 31, 1868, gives the capital invested in the mines and furnaces as $352,250.64, with the notation, "all of which belongs to me." Joseph Wharton, Journal, Box 26, WP. However, in an entry the following day he noted that he owned all but a few shares, "say $500 worth." Gap Establishment, Box 28, WP.

[45] Box 20, WP.

[46] Camden Ledger, Box 26, WP. There is no profit-and-loss statement for the year 1868. Also, Wharton's share of the profits from the firm of Wharton and Fleitmann are not specified in the surviving records. For world prices of nickel, see W. P. Blake, "Nickel," 408; Joseph Wharton, "Addendum," *Statement Made January, 1866, Relative to Nickel, Cobalt-Oxide, Etc.*, 19.

[47] Joseph Wharton, *Memorial to the Senate and House of Representatives* (February, 1872), 3.

[48] Joseph Wharton, *Statement Made January, 1866, Relative to Nickel, Cobalt-Oxide, Etc.*, 2.

Nickel Works was satisfactorily running he wanted a tariff of at least forty cents a pound on nickel and nickel-copper alloy, thirty cents a pound on matte and 45 percent ad valorem on German silver.[49]

Wharton sometimes complained that the mint was buying large amounts of nickel from England. Nevertheless, during the years that he was putting his nickel business together he was the mint's chief supplier. In the prosperous post-war period the mint issued large numbers of nickel-alloy three- and five-cent pieces. From 1865 to 1869 it consumed for coinage 253,111 pounds of nickel. Wharton's records show that during the same period he sold 224,347 pounds of nickel to the mint, this being almost 89 percent of the amount it used.[50]

Then, the mint almost dried up as an outlet for Wharton's nickel. When the post-Civil War prosperity ended and the demand for small change fell off, it drastically restricted coinage of the three- and five-cent pieces. The amount of nickel which the mint consumed in the thirteen-year period from 1870 to 1882 was 64,489 pounds, considerably less than the 75,828 pounds used in the single year of 1868.[51]

The mint was acting in response to congressional policy which in turn reflected conciliation among a wide variety of interests, of which Wharton's interest in nickel manufacturing was a very small one. Although Wharton may have understood this situation, he never accepted it. Because the mining and refining of nickel were basic to the manufacture of nickel articles, he believed that his interest should have precedence over those of German silver makers and other consumers of nickel. Because, as he honestly believed, the mint had encouraged him to enter the nickel business to supply the country's needs for small change, it—and the Congress which governed it—had a special obligation to support his nickel business. He looked on the mint as a manufactory engaged in a highly profitable industry of making small change at his expense. Accordingly,

49 Joseph Wharton, "Addendum," *ibid.*, 19.

50 Figures on pure nickel used by the U.S. mint are compiled from those given in troy ounces in W. P. Blake, "Nickel," 413. Those concerning Wharton's sales of nickel to the mint are from a manuscript ledger in his handwriting in Box 24, WP.

51 W. P. Blake, "Nickel," 413.

when the mint cut back on purchases, Wharton felt abandoned by the government and was not slow in expressing outrage in blunt and colorful language. A characteristic outburst appears in a letter he wrote June 23, 1869, to Secretary of the Treasury George S. Boutwell upon a decision of the government not to purchase a lot of nickel he had manufactured to its specifications:[52]

Dear Sir:

Our interview this morning rather weakened my faith in plain truth telling and frank dealing, though I appreciated the courtesy of your conduct.

I have never been a whisky thief nor a New York imposter nor a leech upon the Government in any way; but on the contrary, to serve the Government in its embarrassment arising from inability to get nickel even at extreme prices, and upon what then seemed to me sufficient assurance of the mint's support, I voluntarily six years ago turned from a life of opulence and reputation to establish the production of nickel in this country. My pertinacious disposition has led me to do this in so thorough a manner that I now have almost the best nickel establishment in the world, and have over $400,000 invested in it. The result to the Government of this sacrifice on my part is partly shown by the enclosed letter from the late Director of the Mint.

At this moment I am more necessary to the Mint than the Mint is to me, and it is quite in my power to reduce that establishment to the same uncomfortable position from which I rescued it.

I was the only person in the nation possessing the necessary skill, means, and courage to build up this costly and troublesome establishment, of which I have borne all the burden while the Government has reaped the profit; if now my Government acknowledges no equity and sees no interest in keeping it alive, I had better abandon it and settle down to become an incubus upon the labor of others, though I revolt at the idea.

Wharton's records show that he sold no nickel to the mint in the years 1870 and 1871.[53] The trade in German silver was also

52 Joseph Wharton to G. S. Boutwell, June 23, 1869, Box 19, WP. In 1883 Wharton charged that, "By consuming about $600,000 worth of nickel, bought from me in the course of say 20 years, the Mint has made a profit on nickel coinage which is several times as much as the total cost of the nickel." Joseph Wharton, *The Duty on Nickel* (Feb. 5, 1883), 6. For Wharton's opinion concerning the obligation of the mint, see also Joseph Wharton, *Suggestions Concerning the Small Money of the United States*, 27–28. For his opinion with respect to the protection of domestic industries by the government, see Joseph Wharton, "National Self-Protection," *The Atlantic Monthly* (September, 1875), 215, 298–315.

53 Box 24, WP.

slow. In 1870 he probably avoided a loss by partially closing down operations for several months.[54] A Memorial which he wrote to Congress in 1872 contains the rather melodramatic statement "that sooner than undergo another period like the years preceding [1871], I would abandon the business, thus silencing the only nickel works in America."[55]

In effect, after 1869 the Philadelphia mint ceased to provide Wharton with much income. In 1879 the mint's facilities became taxed to a point that the blanks or planchets from which the bronze cents were cut were purchased from private parties. The mint began buying the blanks for the coinage of nickel-alloy coins in 1886. In that and subsequent years to 1898 Wharton got the contracts for making the bronze and nickel-copper blanks; but in order to get them he had to bid low. He had the blanks manufactured by the Scovill Manufacturing Company of Waterbury, Connecticut. He rarely made more than $10,000 a year from this business.[56] A sentence which he wrote in 1890 summed up the situation well: "It is safe to say that no one ever did or ever will grow rich by supplying nickel to the United States Mint."[57]

His efforts at getting Congress to raise the tariff on nickel had a partial success in the law passed July 14, 1870, whereby the duty on nickel was increased from fifteen to thirty cents a pound and that on nickel oxide and nickel alloys was set at twenty cents a

54 The production of nickel and cobalt from the Gap Mine in 1870 was 28,989 pounds, as compared with almost five times that much the previous year and almost four times as much in 1871. Gap Establishment, Box 28, WP.

55 Joseph Wharton, *Memorial to the Senate and House of Representatives of the United States of America*, 2.

56 The Scovill Manufacturing Company was one of the earliest and most continuous buyers of Wharton's nickel. For decision by the mint concerning the purchase of blanks for small coins, see *Annual Report of the Director of the Mint*, for the following years: (1879–1880), 5; (1887–1888), 20; (1888–1889), 19; (1889–1890), 20; (1890–1891), 27; (1891–1892, in *Annual Report of the Secretary of the Treasury on the State of the Finances for the Year 1892*), 143, 145; (1892–1893, in *Annual Report of the Secretary of the Treasury*), 152; (1894–1895), 73–74; (1895–1896), 85.

Wharton's financial records concerning contracts with the United States mint are found in Ledger, Private Accts., Box 30, WP. In addition to individual entries there are balance sheets headed "Mint Contracts" from 1886 to 1892 and "Scovill Manufacturing Company" from 1892 to 1898.

57 Joseph Wharton, "A Little Story About Ores," a letter to the editor, *The Nation* (May 1, 1890), No. 1296, 351.

pound.[58] This protection very likely did much to account for the jump in his profits, from $36,882.05 in 1870 to $66,458.29 in 1871.[59] The latter year, indeed, inaugurated the most profitable decade of his nickel business, not only in monetary terms but also with respect to his contribution to improving the metallurgy and increasing the uses of nickel.

The boom came from a decision of the Prussian government to use nickel alloy in making five- and ten-pfennig pieces. Prussia had recently succeeded in uniting the German states and was ready to provide a common coinage for the new Reich. As the world production of nickel in 1873 was only about 700,000 pounds,[60] the Prussian government's decision was a major unsettling factor in the market for the metal. Manufacturers could plan on selling all the nickel they could refine and watch the price offered for it soar.

Wharton was on his first trip to Europe when the Prussian government was considering the measure. He kept a diary of the trip, in which he recorded various travels, inquiries, and negotiations which he made concerning the trade in nickel. In one of the back pages of the diary he made a list of the probable minimum and maximum production of nickel for 1873 of each of the world's suppliers. He estimated that the American Nickel Works would provide about one-fifth of the total world output for that year. Evans and Askin would be the only firm producing more than Wharton. H. H. Vivian of Swansea, England, and Fleitmann and Witte were estimated as being in a tie for third place with an output very nearly that of Wharton.[61]

In the entry for June 24 Wharton recorded "a charming ride of 2 hours" to Iserlohn: "found Dr. Fleitmann friendly, his wife amiable and lovely. Talked with him till 11½ over champagne." The next day Wharton toured part of the works of Fleitmann and Witte and continued the talks before leaving for Dortmund and Cologne. In the entry for July 1 Wharton recorded, "He [Fleitmann] thinks it well for me to see the German authorities at Berlin, but

[58] *Tariff Acts Passed by the Congress of the United States from 1789 to 1909*, H. R. Document #671, 61st Congress, 2nd Session (Washington, D. C., 1909), 273.

[59] Private Accounts, Joseph Wharton, Box 21, WP.

[60] W. P. Blake, "Nickel," 410.

[61] Joseph Wharton, Diary of a Trip to Europe, 1873, Box 8, uncatalogued WP.

not to offer to sell to them; rather to offer to aid the German nickel makers. If nickel should be needed from me he would take it and allow me the same price his firm gets." The entry for July 2 shows that Wharton followed Fleitmann's advice: "Went by appointment to the [Prussian] Mint and had a long talk with the Director."

> The nickel coinage law has passed the Reichstag, and is waiting action of the Bundesrath [*sic*] who will probably pass it.
>
> Fleitmann will probably get contracts for making the blanks. I left corrected copy of my treatise on small coins, and declined to offer nickel for sale, but gave assurance of sufficient supply and expressed preference for aiding Fleitmann if necessary by furnishing nickel to him.

Following these negotiations Wharton talked with other European makers of nickel, including Henry Wiggin of Evans and Askin. Of the latter firm Wharton recorded on August 7, "They incline to have a good understanding with me, and Wiggin promises to send his prices current on circulars issued to customers." Apparently Evans and Askin wanted a share of the American market in exchange for Wharton's sales in England and on the continent, for Wharton also recorded, "Wiggin did not suppose I meant to exclude them from American market, but I said that practically it would amount to that, as I should keep my price down, and if necessary would sell in England, though hitherto I had refrained from doing so."

In other words, Wharton planned in advance of the anticipated world shortage of nickel to keep the price of nickel charged to United States customers well below what it would bring abroad. Only by doing so could he be sure of keeping control of the domestic market. He knew that a large increase in the world price of nickel might offset the protective aspect of the tariff. When the world price was sufficiently high, foreign manufacturers could import nickel into the country, pay a high tariff and sell their product equal to or below the world price and still make a profit. Wharton could forestall this invasion of the American market only by setting the domestic price at a level sufficiently below the world price so that the tariff would continue to give him protection.

In the four-year period from 1873 to 1877 the Prussian government consumed in coinage about 800,000 pounds of nickel. The

world price rose to approximately $3.00 a pound.[62] Wharton did as he had planned and shipped large quantities of nickel to England and other countries, primarily to purchasers whose normal source of supply had been impeded when the European manufacturers diverted a large part of their production into the lucrative Prussian market. Later, in a polemic concerning the tariff, Wharton summarized the market during those years:

> *Germany paid nearly double as much for its nickel as the United States did.* The lofty, unselfish European nickel makers rigged the market on Bismarck, and ran the price up to three times what it had been—it even seemed doubtful whether an adequate supply could be had, but I was fortunately able to spare nickel to Europe and sent large quantities over there at a fine profit, making far more gain from Germany's nickel coinage than all I ever made from that of the United States. It was from the accident of Germany deciding to coin nickel . . . that I made most of what money the nickel business has yielded me.[63]

In the four years from 1873 to 1876 Wharton made a profit on his nickel business of more than $1,239,000, which was considerably more than the total profits from it in all of the other years in which it existed.[64] Moreover, the profits he made during the period of the Prussian coinage came to him mostly in gold and at a time of severe economic depression in the United States. The buying power of such an income at that time was very great indeed.

The boom ended in 1877 when the world market suddenly became flooded with nickel from a new source, Noumea or, to use the English term, New Caledonia, a French penal settlement in the South Pacific. A civil engineer named Jules Garnier had discovered rich silicate ores of nickel there about 1863. These were also styled oxide ores. They produced an excellent quality of nickel and did so much more easily and cheaply than did the sulfide ores of Europe and North America. The refinement of Noumean ores shipped to

62 W. P. Blake, "Nickel," 408–409.

63 Joseph Wharton, *The Duty on Nickel*, 7. See also Joseph Wharton, "National Self-Protection," note, 303.

64 Private Accounts, Joseph Wharton, Box 21, WP; American Nickel Works, Box 28, WP; Gap Establishment, Box 29, WP.

France started in 1876.[65] Naturally, the price of nickel tumbled, from approximately $2.50 a pound in 1876 to $1.50 in 1877 and ninety cents in 1878. After remaining fairly steady at that level for a few years the price dipped again, to about sixty cents a pound in 1885.[66] This change in world market conditions resulted in the closing of nickel mines and many refineries and the formation in 1880 of the first large corporation in the industry, called *Société Anonyme Le Nickel (Système Garnier)*, familiarly known as "Le Nickel," which controlled the output from New Caledonia. Backed by the Rothschild interests, it was suspected of wanting to force prices down until all other refiners left the field. "No nickel mine and only two or three nickel works in Europe have survived the attacks of Le Nickel," wrote Wharton in 1888.[67]

Wharton had analyzed the New Caledonian ores at least as early as 1874 and had even worked out a process for refining them at the American Nickel Works.[68] He realized their potential and was prepared for the glut which they occasioned in the nickel market. Nevertheless, when the Prussian coinage ended, the profits of Wharton's nickel business fell off dramatically, to a mere $6,411.87 in 1877 and $59,452.55 in 1888. Then, however, profits climbed to respectable levels and stayed there for the next four years.[69]

Wharton's experiments at improving the metallurgy of nickel and

65 W. P. Blake, "Nickel," 406–407; F. B. Howard-White, 54–59. In 1893 Stephen H. Emmens, "The Metallurgy of Nickel," 353–354, estimated the cost of production of a pound of nickel from the Garnierite ores of New Caledonia as twenty-two cents, compared with a cost of thirty-one cents per pound for nickel produced from pyrrhotite ores such as those of the Gap deposits.

66 F. B. Howard-White graphically illustrates the fluctuations in the published price of nickel from 1840 to 1961, 308–309. These and other reports of the world or U.S. price for nickel should be understood as representing general price levels for the industry, not as the specific prices which manufacturers might have received. Actually, the variation in price for different grades of nickel was considerable.

67 Joseph Wharton, letter to editor, *Lock and Bell*, 2. See also F. B. Howard-White, 58–59; W. P. Blake, "Nickel," 406–407; "A Nickel Syndicate," *The Mining Journal* (London, England, Feb. 25, 1888), LVIII, 210. In 1889 Le Nickel tried to persuade the Canadian Copper Company, which was developing the Sudbury deposits, to agree to let them have control of their entire output. John F. Thompson and Norman Beasley, *For the Years to Come, A Story of International Nickel of Canada* (New York and Toronto, 1960), 57–58.

68 Ms. in Wharton's handwriting describing the processes used at the American Nickel Works in 1874, Box 24, WP.

69 Gap Establishment, Box 28, WP; Gap Establishment, Box 29, WP; American Nickel Works, Box 28, WP.

finding new uses for the metal belong to the first fifteen years of his nickel business. As early as 1870 he published a scientific paper giving the results of two lines of experimentation. One was concerned with the properties of several sorts of nickel crystals, emphasizing their toughness and magnetic quality. The other concerned a reaction of molten nickel-copper alloy when poured into water.[70] Later, he described the results of some other experiments: "In the years 1874 and 1875 I made a number of articles of malleable nickel, the first that had been produced, for though laboratory experiments with minute quantities had shown that pure nickel could be made with toughness resembling that of iron, the only nickel known to metallurgists was in the form of brittle grains or cubes, useful only when alloyed with the tougher metals, copper and zinc. . . . In the years 1875 and 1876 I made a number of pure nickel magnets of horseshoe and bar shapes, thus entering upon an almost unexplored field, though it had long been known that both nickel and cobalt were attracted by steel magnets. Some of these were mounted as magnetic needles, and I also had made several complete ship compasses, the needles of which were of pure nickel."[71] Wharton gave a nickel compass to each of the governments of the United States, Great Britain, France and Russia. In Russia the Imperial Academy of Sciences subjected the compass to an elaborate series of tests.[72]

Wharton exhibited the products of the American Nickel Works in some of the principal international fairs, including the Vienna Exhibition of 1873, the Centennial Exhibition in Philadelphia in 1876, the Universal Exposition of 1878 in Paris and the Paris Exposition of 1889. His exhibits emphasized the quality products and the new uses with which he had been experimenting. The nature of his display in Paris in 1878 was, in his own words, "Nickel and cobalt ores and products, the latter including commercial nickel in grains and cubes, extra pure nickel, cast nickel anodes for nickel plating, wrought or hammered nickel in several forms, a pure nickel magnetic needle, metallic cobalt in grains and castings, nickel and

70 Joseph Wharton, "On Two Peculiar Products in the Nickel Manufacture," *The American Journal of Science and Arts* (New Haven, 1870), XCIX, 365–368.

71 Joseph Wharton, "The Production of Nickel and Cobalt in 1896," 15–16.

72 *Loc. cit.*

cobalt salts, sulphate of copper or blue vitriol, specimens of nickel and cobalt plating."[73] This display, like those which Wharton entered at the other fairs, was unspectacular as far as the general public was concerned, although it caught the eye of the experts. The awards which he received included an honorable mention in 1873, the standard bronze medal given all exhibits deemed worthy of an award in 1876, and the gold medal in 1878.[74]

At the Paris Exhibition of 1889 Wharton displayed some bars of nickel-tungsten alloy which he considered to represent another important metallurgic advance. Since 1887 he had been experimenting with increasing the magnetic moment of nickel by the addition of tungsten, and the bars were evidence of his success. But the public received his exhibit with indifference. As he reported later, "No notice was taken of them; they were not returned to me, and no trace of them could be found at the close of the exhibition."[75]

As Wharton's nickel business declined he again had trouble with the tariff. In 1881 he discovered that 95 percent nickel was entering the country paying the duty of twenty cents a pound for alloy instead of the thirty cents for pure nickel. In a complaint to the newly created Tariff Commission he explained the situation:

> The duty, as has been said, was 30 cents a pound upon nickel, while it was only 20 cents a pound upon nickel alloyed with copper. This meant that the article to be admitted at 20 cents per pound should be composed one-half of copper and one-half of nickel, or about those proportions. I have a right to say this, because I wrote those words in the law myself, and know just what was meant, and know it was thoroughly explained to the law-makers in both houses of Congress, and that such was the intention of the law. Commercially pure nickel at that time contained about 95 per cent of nickel, and the alloy of copper with nickel was about half and half.[76]

Wharton blamed the Treasury for the adverse interpretation of the provision of the tariff law concerning nickel and appealed to Charles J. Folger, Secretary of the Treasury, for return to the originally intended meaning; and he asked Congress for a change in

73 Joseph Wharton, "Information for the Jury, Universal Exposition of 1878 at Paris," Box 24, WP.

74 W. P. Blake, "Nickel," 419–420; W. P. Blake, "The Metallurgy of Nickel in the United States," 279–280.

75 Joseph Wharton, "The Production of Nickel and Cobalt in 1896," 16.

76 Joseph Wharton, *The Duty on Nickel*, 3, 11.

the law. Wharton was fighting against odds. American manufacturers using German silver and nickel for electroplating liked the lower tariff, which allowed them to buy a principal raw material more cheaply, and they had fairly good access to Congress. Also, Wharton had a bad press resulting from the years in which he had made large profits from nickel. He had to answer charges stemming variously from Congress, reporters, and letter writers that he was making exorbitant profits in a monopolistic situation from an article which he could produce more reasonably than he claimed.[77]

The congresses which reconsidered the tariff act between the years 1882 and 1896 were unsympathetic to Wharton's pleas. The Congress in 1883 lowered the duty on nickel to the pre-1871 level: German silver would still pay a 25 percent ad valorem tariff, but nickel, nickel oxide, nickel alloy and the nickel content of ore and matte would pay a duty of fifteen cents a pound.[78] Although because of the reduced market price of nickel these figures left the duty at roughly 25 percent, which it had been in 1871, the reduction put Wharton at a competitive disadvantage. He had closed the Gap Mine in 1882. He kept it closed for almost two years. In 1883, for the first time since 1865, he operated the nickel business at a loss.

Wharton's papers show that about this time he contemplated a pooling arrangement with Le Nickel. A draft agreement in his handwriting stipulates that Le Nickel would leave the American market to Wharton in exchange for which Wharton would buy matte in excess of what the Gap Mine could produce and nickel in excess of 400,000 pounds per year from Le Nickel.[79] There is no evidence that this agreement ever went into effect or even reached the stage of being sent to the managers of Le Nickel for their consideration.

The vein of nickel ore at the Gap Mine was thinning out. Although

[77] For a characteristic appearance before Congress see *Verbatim Reports of An Interview Between Delegation of Manufacturers and the Committee of Ways and Means of the House of Representatives at Washington April 28, 1874* (Philadelphia, 1874), 6–7. An editor sympathetic to Wharton commented, "Probably no one person in this country, and no one of its industries, have been more industriously and picturesquely lied about than Mr. Wharton and his production of nickel." Editorial note prefacing Joseph Wharton, letter to the editor of *Lock and Bell*, reprinted in *The American* (July 21, 1888), No. 415, 222.

[78] *Tariff Acts Passed by the Congress of the United States from 1789 to 1909*, 329.

[79] Ms. in Wharton's handwriting, Box 24, WP.

Wharton reopened the mine in 1884 and recorded profits from it for that year and for 1885, he lost money on it in every year thereafter. He worked it sporadically after 1888 and finally closed it in 1891, although his books show sales of matte from the mine (probably from accumulated stocks of ore) to the American Nickel Works for two more years. He professed a belief that the mine still contained nickel ore, and that at some time in the future it might be worked again.[80] It was not, however, reopened. As tests made during the Second World War proved, the deposits of nickel ore which remained were too small to have any commercial value.[81]

Wharton kept the refinery operating until he finally disposed of it in 1902. The reasons why he retained it in active use are not clear. He had since the time of the Civil War become a very rich man. The increase in his total assets after 1877 ranged from approximately $200,000 to more than $1,000,000 each year, most of which came from investments in iron, railroads, and real estate. By contrast, the nickel business lost money in 1893 and 1894; and although in some years it made a respectable profit, he progressively devalued it in his yearly balances: from $757,435.71 on January 1, 1883, to $368,437.22 ten years later, to a final figure on January 1, 1902, of $294,814.37.[82]

He possibly kept the American Nickel Works running in the hope of using it as leverage to benefit from the newly opened Sudbury deposits. His papers show that in 1888 he contemplated selling it to the Canadian Copper Company, which mined those deposits, as part of a transaction which would have given him 4,000 of the 40,000 shares of the Canadian Copper Company's stock.[83] Whether

80 Gap Establishment, Box 29, WP; Joseph Wharton, "The Production of Nickel and Cobalt in 1896," 3; W. R. Ingalls, 344–345.

81 F. B. Howard-White, 60.

82 Total profits of Wharton can be found in, for 1876–1884, Ledger, Private Accts., Box 29, WP; for 1885–1898, Ledger, Private Accts., Box 30, WP. The valuations of his nickel business are to be found in loose manuscript sheets inserted in the following ledgers: for Jan. 1, 1883, Ledger, Private Accts., Box 29, WP; for Jan. 1, 1893, American Nickel Works, Box 28, WP; for Jan. 1, 1902, Nickel Business, Box 30, WP.

83 Ms. in Wharton's handwriting, Box 24, WP. Wharton's books show that at a somewhat later date he had small investments in Canadian nickel and copper. Thus, in every year from 1892 to at least 1898 he listed several thousand dollars under the heading, "Sudbury Venture," referring to the Beatrice mine near Sudbury, and in 1897 and 1898 he had $24,544.75 and $19,100.58 respectively invested in "Murray Mine"—one of the principal mines at Sudbury. American Nickel Works, Box 28, WP.

he actually presented this proposal to the managers of that company cannot be determined. Also, he might have held on to the refinery hoping to profit from the discovery of a strategic use for nickel in the manufacture of nickel steel. The final disposition of the refinery was bound up with these events.

The companies involved in developing the Sudbury deposits which were of greatest interest to Wharton were the Canadian Copper Company and the Orford Copper Company. The former did mining. The Orford Company did refining and located its plant near Constable Hook, New Jersey.[84] As their names suggest, these companies were originally formed to mine and refine copper, not nickel. Indeed, the Orford Company discovered that it had to deal with 2½ percent nickel ore as well as 4½ percent copper ore only after the usual refining methods failed to produce pure copper. The attitude of the managers of these companies toward nickel appears in the testimony given by Stephenson Burke, one of the founders of the Canadian Copper Company, before the Subcommittee on the Tariff of the Senate Finance Committee in 1889. The burden of his remarks was that copper pays, nickel doesn't: "with the extent of our mines we must produce several times as much nickel as the world has ever yet used. . . . I expect to see nickel sold at 10 cents a pound." Nickel, he said, was a byproduct of copper mining. He asked Congress to lower the tariff on copper and copper ore coming into the United States. The tariff was then two and one-half cents a pound for copper in ore and four cents a pound for copper in bars, pigs, etc. He told the Subcommittee that if Congress would remove the tariff, especially on copper ore, the refining would be done in the United States; otherwise it would have to be done in Canada.[85]

Congress basically adopted Stephenson's position. The McKinley Act of 1890 reduced the tariff on copper in pigs, bars, etc. to one and one-half cents a pound and in ore to one-half cent per pound. It also put ores of nickel and nickel matte on the free list, except for nickel ores containing more than 2 percent copper (that is, the Sudbury ores), where the duty of one-half cent per pound on copper

84 John F. Thompson and Norman Beasley, 22–36, 53.

85 *Testimony Taken by the Subcommittee on the Tariff of the Senate Committee on Finance, Pt. IV, January 16, 1889* (Washington, D. C., 1889), 2235.

contained therein would have to be paid.[86] The Wilson-Gorman Act of 1894 put both copper in pigs and bars and in ore on the free list.[87] These congressional acts benefitted not only the copper refineries of the United States but also the nickel refineries at Camden and Constable Hook. There was at the time and later talk in Canada of imposing an export duty on copper and nickel ores to prevent this flight of industry to the United States. Nothing was done, however, and the talk was still going on in 1902.[88]

Wharton respected the potential of the Orford Copper Company. Although it did not produce the high quality nickel of his own refinery, which commanded a premium price, its management was alert, aggressive and inventive. It developed a relatively cheap process for separating the nickel from the copper in the Sudbury ores. Variously called the "soda process," "Orford process," and "tops and bottoms process," it was patented in the United States and in various foreign countries in 1893.[89] As Wharton described the process, the matte was first freed of most of the iron and "then smelted in a cupola furnace with sodic sulphate and coke. The product of this fusion drawn off into suitable vessels divides by gravity while fluid into two portions, a lighter and a heavier, easily separable when cold, the lighter, called tops, contains nearly all the soda, copper, and iron, while the heavier, called bottoms, contains nearly all the nickel. . . . From the tops metallic copper is ultimately produced. The very small quantity of cobalt present goes with the nickel and there remains. The nickel sulphide just named becomes, when dead roasted, nickel oxide, which is considered good enough for use in producing nickel steel."[90]

The discovery of nickel steel was associated with a search for better forms of steel for plating warships with armor. Wharton stood to benefit from this development from his investment in the Bethlehem Iron Company. His assets in Bethlehem Iron during the

86 *Tariff Acts Passed by the Congress of the United States from 1789 to 1909*, 384–385, 412.
87 *Ibid.*, 497.
88 *The Iron Age* (May 1, 1902), 25.
89 John F. Thompson and Norman Beasley, 89–90.
90 Joseph Wharton, "The Production of Nickel and Cobalt in 1896," 8. See also Robert M. Thompson, "The Orford Nickel Process," *The Mineral Industry, Its Statistics, Technology and Trade in the United States and Other Countries* (New York, 1893), I, 357–358. Robert M. Thompson was inventor of the Orford process.

1890s were from three to four times as great as the total worth of his nickel business. In 1886, when the Department of the Navy advertised for bids for making armor plate and ordnance, Wharton and several other directors of the Bethlehem Iron Company succeeded in getting the Board to authorize a bid, which was accepted. The Bethlehem Iron Company reorganized production to concentrate on the new product. By this time French, English, and German armor plate manufacturers were reporting successes using nickel steel alloys. Very shortly thereafter an American, Hayward Augustus Harvey, made an improvement by cementing nickel on the surface of a plate of nickel steel, thus giving an added hardness needed for pulverizing the projectiles then used in guns. Following successful tests of Harveyized nickel steel armor, B. F. Tracy, Secretary of the Navy, arranged with the Bethlehem Iron Company for it to be used exclusively.[91]

Congress insisted that gun forgings and armor plate should be of domestic material and manufacture. That effectively prevented the use of nickel imported from Europe and favored the American refineries at Camden and Constable Hook, which used matte from the Sudbury ores. In fact, the Bethlehem Iron Company bought its nickel from the Orford Copper Company, leaving German silver makers, whose numbers in the country were increasing, to purchase the higher quality product made by the American Nickel Works.[92]

When the advantages of nickel steel for armor plate had been proved, all the major countries of the world began using it in modernizing their navies. The amount of nickel needed for the alloy was small—inventories of nickel of the Bethlehem Iron Company for the years from 1897 to 1899 showed less than $25,000

91 W. Ross Yates *et al, Bethlehem of Pennsylvania, Vol. II, The Golden Years, 1841–1920* (Bethlehem, Pa., 1976), 116–118; John F. Thompson and Norman Beasley, 53–61; Francis L. Sperry, 55–61.

92 Several of the contracts of the Bethlehem Iron Company with the Department of the Navy can be found in the Minutes of the Board of Directors, Schwab Memorial Library, for example, the contracts dated Mar. 16, 1892 (117–118) and July 30, 1892 (122). Wharton's financial accounts contain no record of sales of nickel to the Bethlehem Iron Company. On the other hand, Wharton's correspondence on behalf of the Bethlehem Iron Company reveals purchases from the Orford Copper Company. Boxes 11 and 12, WP.

worth on hand in any year.[93] Still, the use of nickel steel for armaments drew the attention of manufacturers to the metal. It received a priority in their thinking which it had not had before. Stockpiles at Sudbury went down as the trade picked up. "Nearly all the nickel consumed in making nickel-steel armor plates for the United States Navy has been derived from the Canadian Copper Company's mines, and very large quantities in the forms of nickel oxide and metallic nickel manufactured from its matte by the Orford Copper Company at Constable Hook near Bayonne, New Jersey, have been since 1890 exported by the latter company to Europe," wrote Wharton.[94] Various scientists and engineers began experimenting with new processes for refining nickel ores, among them Ludwig Mond, N. V. Hybinette, and Thomas A. Edison.[95] In 1899 the Bethlehem Steel Company (the name had been changed in that year) rolled and successfully tested the first nickel steel automobile axle, thus promoting acceptance of the alloy by the infant automobile industry.[96]

Wharton knew as well as anybody that the corporate character of American industry was changing in the direction of bigness. Early in 1901, the United States Steel Corporation was formed with Charles M. Schwab as its president. A few months later Wharton and Robert P. Linderman, president of the Bethlehem Steel Company, engineered that company's sale to Schwab as a private investment. Some of the principal owners of Sudbury properties then called upon Schwab to perform another task of organization. The result was the formation under Schwab's direction on March 29, 1902, of the International Nickel Company. It was originally a holding company for seven subordinate concerns, of which the Canadian Copper Company and the Orford Copper Company were the principal producers.[97]

Wharton's American Nickel Works was one of the five smaller

93 Minutes of the Board of Directors, Bethlehem Iron Company, show the following inventories of nickel on hand: May 31, 1897, $17,532.02; May 31, 1898, $23,783.30; Apr. 30, 1899, $21,766.78.

94 Joseph Wharton, "The Production of Nickel and Cobalt in 1896," 5–6.

95 *Ibid.*, 7–9; Stephen H. Emmens, "The Metallurgy of Nickel," 354–356.

96 John F. Thompson and Norman Beasley, 131–133.

97 *Ibid.*, 142–143; *The Iron Age* (Apr. 3, 1902), 45.

companies of the new corporation. A note in Wharton's handwriting indicates that the property conveyed to the "projected new nickel company" included not only the Camden refinery but also the Gap Mine, the smelters, the associated machinery and the "chattels of all sorts" including "stuff in process, materials and finished goods."[98] Wharton became one of the directors of the International Nickel Company. The two largest security holdings on his books as of January 1, 1907, were $2,390,000 worth of Bethlehem Steel Company bonds and $1,040,000 worth of International Nickel Company stock.[99]

The American Nickel Works was merged with the Orford Copper Company in 1905, thus ending that vestige of Wharton's nickel business.[100] By then Wharton's pioneering enterprise in nickel had been all but forgotten. It had been a small undertaking. Although, according to Wharton, during the twenty-five years of its operation the Gap Mine "probably yielded . . . as much nickel as any other mine in the world,"[101] its total production of about 4,480,000 pounds was less than half that of the Sudbury district in the normal year of 1901.[102]

Moreover, the mine and refinery had not formed the basis of a great new American industry, as Wharton had hoped they would. The general poverty of the United States in nickel was not suspected at the time Wharton acquired the Gap Mine. Wharton himself believed that other commercially profitable deposits within the several states would be found and worked. But it did not turn out that way, not for another ninety years, until advances in the science and technology of nickel permitted the modest deposits near Riddle in western Oregon to be profitably exploited.

But, although small, Wharton's nickel business was sufficient for most of the needs of American industry in the years before nickel

98 Nickel Business, Box 30, WP.

99 Private books in Box 8, uncatalogued WP.

100 John F. Thompson and Norman Beasley, 166.

101 Joseph Wharton, "The Production of Nickel and Cobalt in 1896," 3.

102 John F. Thompson and Norman Beasley, 22, estimated the total production of the Gap Mine as being 2,000 tons, which is equal to 4,480,000 pounds if the tons are long tons of 2,240 pounds each. The nickel production of Canada in 1901 was 9,189,047 pounds, all in ore and matte. *The Iron Age* (Mar. 20, 1902), 26a.

steel came into widespread use. Wharton's enterprise also added an understanding of the metallurgy of nickel to the store of information which a developing industrial economy needed. Wharton's own scientific and manufacturing accomplishments were respected both abroad and at home, although probably the most enduring monument to his pioneering endeavor, so far as the man in the street is concerned, is the common nickel.

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