Chapter 11

ARIZONA SILVER MILLING FROM TUBAC TO TOMBSTONE:

People, Technology, and Environment, 1856-1906

What is one to make of the ruins of the San Pedro River mills, or the traces of their predecessors across the Santa Rita Mountains and near the one-time Spanish presidio of Tubac, or their descendant, only a scar on the landscape at Tombstone itself? Between the acquisition of the Gadsden Purchase and the erection of the first mill by an American company and the completion of the big works at Tombstone at the beginning of this century, much change occurred within the social, economic, and political world of Arizona Territory. That is an understatement. Imagine that change, if you will, or imagine it as if you were an Apache, or a horse soldier at Huachuca.

For Arizona Silver mining the change was dramatic as well.

Guido Kustel and Silver Mines of the Tubac Area, 1850s

We begin in 1856. The recently formed Sonora Exploring & Mining Company hired the best experienced mining men it could hire and sent them to Tubac, where they operated and began the difficult task of opening the one-time Mexican silver mines in the surrounding hills. For half a decade the company strove to profit from its scattering of claims. After a series of failed attempts with Mexican processes, the company agents turn to San Francisco for European-trained talent. In 1858, forty-one year old Guido Kustel arrived at Tubac.

Born in Galecia, Austria-Hungary Empire, Guido Kustel was educated at the best mining school of the day, the Royal School of Mines, Freiberg, in the heart of the Harz silver mining region of Saxony, Germany. Young men of talent were in demand in the new world and upon graduation Kustel went to Chile as manager of silver mines. In 1851, the lure of the California gold rush drew him north to San Francisco, where he joined the assay firm of Wass, Uznay, and Werwick, a group of exiled Hungarian revolutionaries. The assay company operated one of the largest gold refineries in San Francisco, but, more importantly, provided consultant services to infant mining operations. In 1857, the Sonora Exploring & Mining Company hired the services of the firm to investigate it's properties. They sent Guido Kustel to Tubac.[1]

We have no record of Kustel's report, but he must have been enthusiastic for he quit Wass, Uznay, and Werwick to join the Sonora company. The short, stocky Magyar was described as modest with a retiring disposition and studious habits, the stereotypical image of the German chemist at his lab. He replaced previous, more flamboyant managers with limited knowledge, such as Charles Poston. He abandoned their early works at Tubac and moved to Arivaca near the Cerro Colorado mine to begin the erection of a mill to reduce the silver ores. Kustel knew intimately the Freiberg barrel process for working silver ores, the most advanced process at that time. It included roasting the silver ore to burn off any sulphur and to amalgamate the crushed ore with mercury and copper sulphate in rotating wooden barrels, which produced an amalgam that when refined left silver bullion. Kustel described the process and works of the mill, the first in the U.S., in an article published in the San Francisco *Bulletin* November 6, 1858. In Guido Kustel's view it was a technical success. The plant saved 80 percent of the value, better than the slow Mexicqan pation process.[2]

The importance of the feat was its accomplishment in an incredibly isolated district, in an area of limited fuel, and with a lack of labor familiar with the process. The technology proved successful, but the mining company failed. The isolation meant that pieces of machinery, such as bolts, had to be forged at the site, causing delays and frustrations. A major stockholder of the Sonora company, Samuel Peter Heitzelman, left a diary of events, a woeful chronicle of frustrations with machinery and men, even Kustel or rather his sister attracted his ire.[3] Conflict with Apache—Kustel missed being killed in a raid by a day—and the Mexican workers as well as a lack of working capital combined to close the operation.

The environmental factors against such an operation were phenomenal. To attempt such an undertaking shows the brashness of the business men of the day. The metallurgy, or chemistry of the Freiberg process of Kustel was essentially what was introduced at Tombstone two decades later but the early cost of operation—costs that could be absorbed in Germany or central Mexico but not the sparsely populated arid Southwest—caused the Tubac area applications of European technology to fail. Tubac, however, served as a departure point from the technology of the Mexican patio process used to the south, and the first failures of European models like the Freiberg process, which would evolve into a particularly Western mining technology. Western American isolation and the arid regions lack of fuel, readily available in Europe, caused the need for a new technology. Innovations would occur, but events would shift to Nevada in 1859.[4]

Kustel hastily left Tubac in 1859, but gained fame in Nevada's Comstock lode, just discovered. He designed and built the largest mill on the lode, and wrote a scientific treatise on silver metallurgy. When published in 1863, it caused a sensation because it fulfilled the American need for a simple mining handbook. Kustel would continue to design mills, do consultant work, and publish, becoming one of the best known mining engineers of his generation. In 1863, one of his consultant jobs for Sylvester Mowry brought him back to the Tubac area, a trip chronicled in J. Ross Browne's entertaining articles for *Harper's Weekly*, later published as *Adventures in Apache Country*.[5]

The Janin Brothers and the Arizona Silver Boom, 1870s-80s

Along with Kustel was a young mining engineer, Louis Janin. Janin would be the innovator to transform European and Mexican experience into new methods for the American West, the ones used in the Tombstone mills. Born into a wealthy New Orleans family, his lawyer father had foreseen the need for educated engineers for the emerging Western mining industry, when he sent Louis and two younger brothers (Henry and Alex) to Yale, then to the Freiberg Royal School of Mines, and finally the Ecoles de Mines, Paris. Louis returned to the U.S. during the first years of the Comstock boom in Nevada and quickly rose in the ranks through the kindness of other engineers, like Kustel, and through his own sagacity in studying and perfecting the silver mining process developed on the Comstock and to forever after be known as the Washoe Process.[6]

Arriving at Virginia City, Nevada in 1862, Louis Janin wrote his father: "The metallurgical works are but poor as a general thing and but very few understand their business. The treatment of gold ores is very simple and they even think that silver is the same. The conception is that a great deal of the precious metals is lost." In 1863, as assayer at the Mexican mill and later Gould and Curry mill, he noticed a loss of a large percentage of the silver in sulphides floated away, escaping pan amalgamation. A chemical bonding of silver and sulphur prevented their working in the pan mill. Also a large percentage of value was also lost because of the hasty working of rich ore and the sloppy assay record keeping, which were shoddy to avoid exposing true losses of ore value compared with resultant bullion product. Like others, Janin first tried the Freiberg process then the Mexican Patio process, but both were too costly and slow. Then with his brother Henry, he tried to create the chemical reaction caused by roasting through other means and succeeded. Yet the brothers' patented chemical process proved less effective than just a better control ration of bluestone (sulphate of copper) added to ore in the pan. He analyzed and figured the accurate amount of bluestone and salt needed for the ores, thus improving returns. This simple, but successful modification of the Washoe process made tons of tailings valuable and for a decade tailings mills were operated. On the Comstock lode he perfected the means to economically work the tailings of the wasteful early mills.[7]

During the 1860s through the 1890s, the Washoe process dominated silver milling. It was simply a mechanical expedient of the Mexican patio process where the chemical reaction was caused by "magistral," or blue stone (copper vitriol) and salt. Various chemical substitutes were tried, each being more fantastic than the other. "The only real meritorius process in treating raw stuff in pans," wrote Guido Kustel, "is that adopted simply in the administration of a larger percentage of blue vitriol [copper sulphate]."[8] This Janin had figured out. Millmen were able to improve the Comstock mill silver recovery to 80 percent from 60 percent.[9]

As Virginia City millmen rushed into new districts, they erected the familiar Washoe pan mill. With brothers Henry and Alex, Louis Janin became the foremost experts in the process. Alex Janin, Pioche assayer and brother of Louis, introduced the process into that Nevada boom town. During the 1870s, Arizona entered its silver boom following the discovery of silver ores, from the Cerbat Range

of Mohave County, through central Arizona, and into the old mining region of Tubac and its new neighbors to the east, especially Tombstone.[10]

Louis, Henry, and Alex Janin became the sought after experts for Arizona mining men. During the 1870s he visited nearly every Arizona boom mining camp. The Janin family papers at the Huntington Library, San Marino, California attest to this activity. In the collection are letters from the Peck and Tip Top mines south of Prescott, silver lodes acquired by San Francisco investors who funded mills based on Janin designs. The Harshaw Mining Company sought similar services and company papers and plats are mixed in at the Huntington Library collection. The brothers letters in the file discuss business and technological questions as well as their aspirations. In 1872, Alex wrote his mother, "it is easy for me to make $2,000-3,000 a year but have no respect for such small amounts and I am always ready to risk it all for the sake of making a big strike." The brothers wrote of travels and dangers — travelling 75 hours straight in an open coach across Arizona, all the while subsisting on fat pork and beans — and mining frauds. But, as Louis once wrote, "there are a 1000 reasons (i.e. $) for doing such work." [11]

Like nearly every other mining man, Tombstone attracted the Janin brothers after its 1877 discovery. Along the San Pedro River, from Benson south to Fairbank, the technology of the Washoe Process arose in a series of silver ore crushing mills, the Contention, the Boston, the Tombstone Mill & Mining Company, and the Corbin. These mills, some of the best of their day, used the machinery perfected on the Comstock; by the time of the Tombstone boom the technology was so well known that the mills were simply ordered from catalogs of San Francisco or Denver or Chicago suppliers. They were erected by skilled workman, many from the declining Comstock and once completed they were operated by men more likely apprenticed into the traditions of Western silver milling rather than educated at some distant mining school. The Janin brothers served as technical consultants on which particular design to build.[12]

Alex Janin, in the territory in 1878 and 1879, inspected the Contention mine and made recommendations for the construction of the Contention mill on the San Pedro River. Construction began in October 1879 and the mill reflected the technology of the day. This mill had ten stamps, "ten upright rods of iron, as large as a man's ankle, and heavily shod with a mass of iron and steel at their lower ends, were framed together like a gate, and these rose and fell, one after the other, in a ponderous dance, in an iron box called a 'battery'... The ceaseless dance of the stamps pulverized the rock to powder, and a stream of water that trickled into the battery turned it into a creamy paste." From the battery workers carted the paste to amalgamating pans, large metal tubs that mixed the paste further with a blend of mercury, salt and copper sulphate. The silver and gold was captured by the mercury and the resultant amalgam was put into large "settlers," or tanks. Its discharge was taken to the assay office, where the mercury was heated and vaporized out of the amalgam, the remaining silver and gold melted into a brick of bullion.[13]

The Janins, of course, were not the only engineer sdesigning mills and innovating. Mahlon P. Boss devised an important innovation at the Total Wreck mill at Vekol, which was a closed system milling process that reduced the loss of water, an important factor in the arid Southwest. Even Guido Kustel was in Arizona during the boom. He and his nephew, Ottaker Hoffman, had perfected a method whereby a leaching of the ores would wash away the more difficult to remove silver from its ores. In 1882, the year Kustel died, this lixiviation process was introduced by his nephew at the Silver King mill, Pinal County, Arizona, the first mine plant in the U.S. to successfully use the process. The Silver King continued to pay dividends.[14]

Like Kustel, the Janins took part in Arizona's mining development by innovating and applying European chemical processes to American conditions. This innovation was remarked on by many. C. H. Aaron, Prescott assayer of the 1870s and the 1880s, wrote: "The exigencies of these Western countries have compelled us not only to invent new and economical devices for the reduction of silver ores, but to attempt such reduction under such conditions which would not have been admitted in Europe."[15] The German-educated engineers like the Janins and Kustel brought the technology; everyone in the industry grappled with it and changed it. Still the German influence dominated the new developments in metallurgy-in the chemistry of the Washoe Process, the smelting of ores, and in lixiviation.

William Field Staunton and Revival at Tombstone

While the technology of the Tombstone mills reflected German and Mexican traditions, with bigger steam engines attached, and, occasionally, more metallurgical control, they were also the scene of

the first generation of American educated mining engineers. While Alex Janin was associated with the Contention mill, nearby the Tombstone Mill and Mining Company erected their great mill under the direction of John A. Church, one of the first graduates of the Columbia University's School of Mines. Church hired a string of later graduates, among them William Field Staunton, II. In 1883 Staunton arrived at his first serious job, assayer for the Tombstone company's two mills located at Charleston on the San Pedro River.

Charleston, as Staunton later recalled, was a lively town. "The roar of the stamps in the mill, fading or increasing with the wind but always present, became so familiar that it was only noticed when it stopped and gave everyone a feeling of apprehension at the sudden silence." Staunton worked his way up the company ladder, becoming mine superintendent the next year and then general superintendent, at age 27. While he progressed, the Tombstone district began its decline, mostly because of the decline in the market price of silver, which in turn cut profits at the mines. As the Contention, Grand Central and other of the big producers closed, Tombstone M & M continued through the purchase of the only mill in Tombstone, the Girard, and by milling its low grade ores and shipping the higher grade to the smelter in El Paso. Staunton sought the appropriate technology for his ores in order to continue sending profits East.[16]

By 1893, however, the silver market crashed, and with it came down the West's silver mining industry. Staunton resigned from Tombstone M & M, which closed. For the next eight years he worked in the expanding empire of his new associates, Ephilat B. Gage and Frank M. Murphy. Staunton became the lead mining engineer for these two rising empire builders as the world of mining transformed from single corporations into massive conglomerates in the model of the Standard Oil Company. In 1901, Murphy, Gage, and their backers organized the Development Company of America to be the holding company for a string of mining, smelting, and railroad projects.

Staunton succeeded at the Congress Gold Mine, a Gage and Murphy holding north of Wickenberg. During the 1890s, Staunton acquired more responsibility and was placed in charge of other properties the two men promoted. In 1901, a dream of Gage's came to fruition. After consolidating the best claims at Tombstone during the bust years, he organized the Tombstone Consolidated Mines Co., a subsidiary of the Development Company of America. Gage became president and in 1902 Staunton returned to Tombstone to manage the reopening of the mines.

This was the age of Science - at least the promotional literature boasted of the unification of science with business to more predictable benefit and profit from nature's bounty. Staunton and his peers had witnessed a revolution in metallurgy. During his tenure at the Congress mine he led in innovation, using the latest metallurgical developments to make the gold mine profitable. At Tombstone he would innovate as well, a striving for new equipment or costly innovation that would at times result in confrontations with Frank M. Murphy, keeper of the purse strings.

In the world of silver milling the greatest innovation of the day was the perfection of the cyanide process. The cyanide process was discovered by "three zealous experimenters in a poorly equipped laboratory in Glasgow, Scotland."[17] The three men, chemist John S. MacArthur and medical doctors William Forest and Robert W. Forrest, perfected the process for gold in 1886, but a decade would pass before the mechanical system could be developed for silver extraction.[18]

By the late 1890s silver was being processed. Charles Butters with a staff of assayers, chemists and metallurgists perfected the working of silver ores by cyanide. More difficult to work than gold, silver ores were complicated by the presence of base metals. The development of the Wilfley concentration table and its imitators helped remove the base metals or separate slimes prior to cyanidation. In the late 1890s and early 1900s in Mexico and on the Comstock, Charles Butters and his crew developed the methods to work silver ores and perfected their own separators, agitators, dewaterers and filters. Imitating Butters success at Virginia City, Nevada, Staunton, in 1905, would have the old Girard mill at Tombstone converted to a cyanide process plant. The cyanide process had replaced the old Washoe process, developed nearly fifty years before on the Comstock by mining engineers like Guido Kustel and the Janin brothers.[19]

The cyanide mill worked the lower grade ores and helped make Tombstone Con briefly profitable, but the real problem at Tombstone was the water in the mines, a different but related story. Ultimately, the inability to pump out the water would cause the collapse of Tombstone Con, but by then Staunton was busy managing projects across the territory, directing the erection of a copper smelter and opening

copper mines at Silverbell, developing copper claims near Winkleman, opening gold and silver mines around Prescott. Staunton had become the exemplary American mining engineer romanticized by Richard Harding Davis in his turn of the century novels. More importantly, Staunton was an innovator and experimenter with new technology. Although the Development Company of America collapsed financially in 1911 and took with it the Tombstone Con, Staunton continued to move within the high circles of Arizona mining men who were revolutionizing the industry. But for Tombstone the last silver bullion had been poured at its mills.

The silver mining world was moving away from the production of silver bullion on site. Instead, mills were being converted to produce a concentrated ore that would have higher mineral values and therefore support the cost of shipment to distant smelters. The completion of a railroad to Tombstone in 1903 and the rail net of the Southwest allowed for this ability to ship to distant central smelters, in this case at El Paso, rather than mill the ore and extract the metal on site. This had occurred throughout the West. The old Washoe mills and the few cyanide mills were rapidly being replaced by mills that concentrated the ore prior to shipment to distant smelters. This Staunton had done by 1906. The Freiberg process, the Wahoe process, and, ultimately, the cyanide process for silver extraction became as obsolete as an IBM 3070 Main Frame computer.

Conclusion

The careers of a group of mining engineers - Guido Kustel, the Janin brothers, and William F. Staunton - and the places they worked help us understand the place of innovation, but, more importantly, how that innovation was linked to economic changes. Engineers have invented systems or devices that have produced profound socio-cultural transformations, but each within its own time and place. The Western social-economic system of 1850s Arizona and 1900s Arizona was created, in part, by national social changes, as well as local technological innovation. The appropriate technology was necessary for each era, obviously, in the terms of the environment in which it operated, in terms of technology and its impacts, and in the men and women engineering that change.

Between 1856 and 1906, silver metallurgy changed as rapidly as computer technology has changed in our own time. To describe a silver mill in one time frame as an example of nineteenth century engineering is folly. Silver milling technology went through tremendous and rapid change during the period 1856-1906, from the American-era of opening of the silver mines at Tubac, to the construction of the big mill at Tombstone a half century later.

Endnotes:

1. *Mining and Scientific Press*, August 19,1882.

2. Guido Kustel, *Nevada and California Processes of Silver and Gold Extraction* (San Francisco: Frank D. Carlton, 1863), p. 117; Julius Silversmith, *A Practical Handbook for Miners, Metallurgists and Assayers* (New York, 1867, 116-157).

3. Diane M. T. North, *Samuel Peter Heintzelman and the Sonora Exploring and Mining Company* (Tucson: University of Arizona Press, 1980) *passim.*; Poston in *Apache Land*, pp. 52-3, notes the sister:

But Kustel was of Magyar type, and learned in best Hungarian schools To use assay and mining tools His sister and niece, the fraulein Kline, were company for those at the mine. The fraulein, a most accomplished person, Inspired, somehow, a great aversion.

4. The processes are described in Otis Young, *Western Mining* (Norman: University of Oklahoma, 1970). Herman Ehrenberg, "The Reduction of Silver from its Ores," *Weekly Arizonian* (Tubac), July 21, 1859.

5. Sylvester Mowry, *Arizona and Sonora* is a promotional tract that quotes Kustel's report extensively.

6. R. W. Raymond, "Biographical Notice of Louis Janin," *Transactions of the American Institute of Mining Engineers* v. 69 (1914) pp. 830-836; Eliot Lord, *Comstock Mining and Miners* (Berkeley, California: Howell-North, 1959, reprint), pp. 54-55; Ernest Oberbillig, "Development of Washow and Reese River Silver Processes," *Nevada Historical Society Quarterly* v. 10 (1967), pp. 5-43.

7. Raymond, "Janin," p. 69; Hodge, "Amalgamation," pp. 211-213; Raymond, *Mineral Resources*, 1869, p. 53; Louis Janin to Father, Virginia City, July 5, 1862, July 30, 1864, Janin Family collection, Huntington Library.

8. Raymond, *Mineral Resources*, 1873, pp. 427-433.

9. A. D. Hodges, "Amalgamation at the Comstock Lode, Nevada: A Historical Sketch of Milling

Operations at Washoe, and an Account of the Treatment of Tailings at the Lyon Mill, Dayton," *Transactions of the American Institute of Mining Engineers* v. 19 (1891), pp. 185-202; Lord, Comstock, pp. 113-128; J. Wells Kelly, *First Directory of Nevada Territory*, (Los Gatos, California: The Talisman Press, 1862 reprint 1962), pp. 259-260; Raymond, *Mineral Resources*, 1870, p. 741; James D. Hague, *Mining Industry* U.S. Geological Exploration of the Fortieth Parallel (Washington: G. P.O., 1870), pp. 238-246; For the best contemporary, technical description of the process see J. M. Adams, "The Treatment of Gold and Silver Ores by Wet Crushing and Pan Amalgamation Without Roasting," *Transactions of the American Institute of Mining Engineers* v. 2 (May 1873 - February 1874), pp. 159-171. The amount of return was a major issue between mill owners, who paid 65% of assay value for ore, and mine owners, who after Hague's report demanded up to 80%. In 1892 Nevada passed a law requiring the reporting of assay returns, thus "correcting the abuse of the Comstock mill ring." See *Mining and Scientific Press* March 29, April 12, June 14, 1890, April 16, 23, 1892.

10. Richard W. Fulton, "Millville - Charleston, Cochise County 1878 - 1889, " *Journal of Arizona History*, v. 7 no. 1 (Spring 1966), pp. 9-22; Paul Long, "Mineral Park: Mohave County Seat, 1877-1887," *Arizoniana*, v. 3 no. 2 (Summer 1962), pp. 1-8; David F. Myrick, "Quijotoa, Boom and Bust in the Arizona Desert," *Journal of Arizona History*, v. 34 no. 2 (Summer 1993), pp. 117-154; Robert L. Spude, "A Land Of Sunshine and Silver, Silver Mining in Central Arizona, 1871-1885," *Journal of Arizona History*, Spring 1975, pp. 221-244; Georgia Wehrman, "Harshaw: Mining Camp of the Patagonias," *Journal of Arizona History*, v. 6 no. 1 (Spring 1965), pp. 21-36.

11. Letters in Janin Family MSS, Huntington Library.

12. Patrick Hamilton, *The Resources of Arizona* (San Francisco: A. L. Bancroft & Co., 1884), pp. 154-166; William P. Blake, *Tombstone and Its Mines* (New York, 1902), passim; B. S. Butler, E. D. Wilson, and C. A. Rasor, *Geology and Ore deposits of the Tombstone District, Arizona* Arizona Bureau of Mines Bulletin #143 (Tucson: University of Arizona Press, 1938), pp. 38-48; Odie Faulk, *Tombstone, Myth and Reality* (New York: Oxford University Press, 1872), chapter 3.

13. The process is described in Otis Young, *Western Mining*, but the quotes are from Mark Twain (Samuel L. Clemens), *Roughing It* (1872). Twain worked briefly in a Nevada silver mill.

14. Gregory P. Dowell, "The Total Wreck, Arizona's Forgotten 'Bonanza' Mine," *Arizona and the West*, v. 20 no. 2 (Autumn 1978) pp. 141-154; Oberbillig, "Washoe and Reese River Silver Processed," pp. 5-43; *Mining and Scientific Press* August 19, 1882; "Biographical Notices," *Bulletin of the American Institute of Mining Engineers* no. 39 (March 1910), pp. xxxvi-xxxvii; Ottaker Hofman, *The Hydrometallurgy of Silver* (New York, 1907), passim.; C. A. Stetefeldt, "Russell's Improved Process for the Lixiviation of Silver Ores," *Transactions of the American Institute of Mining Engineers* v. 13 (Fevruary 1884 - June 1885), pp. 47-118.

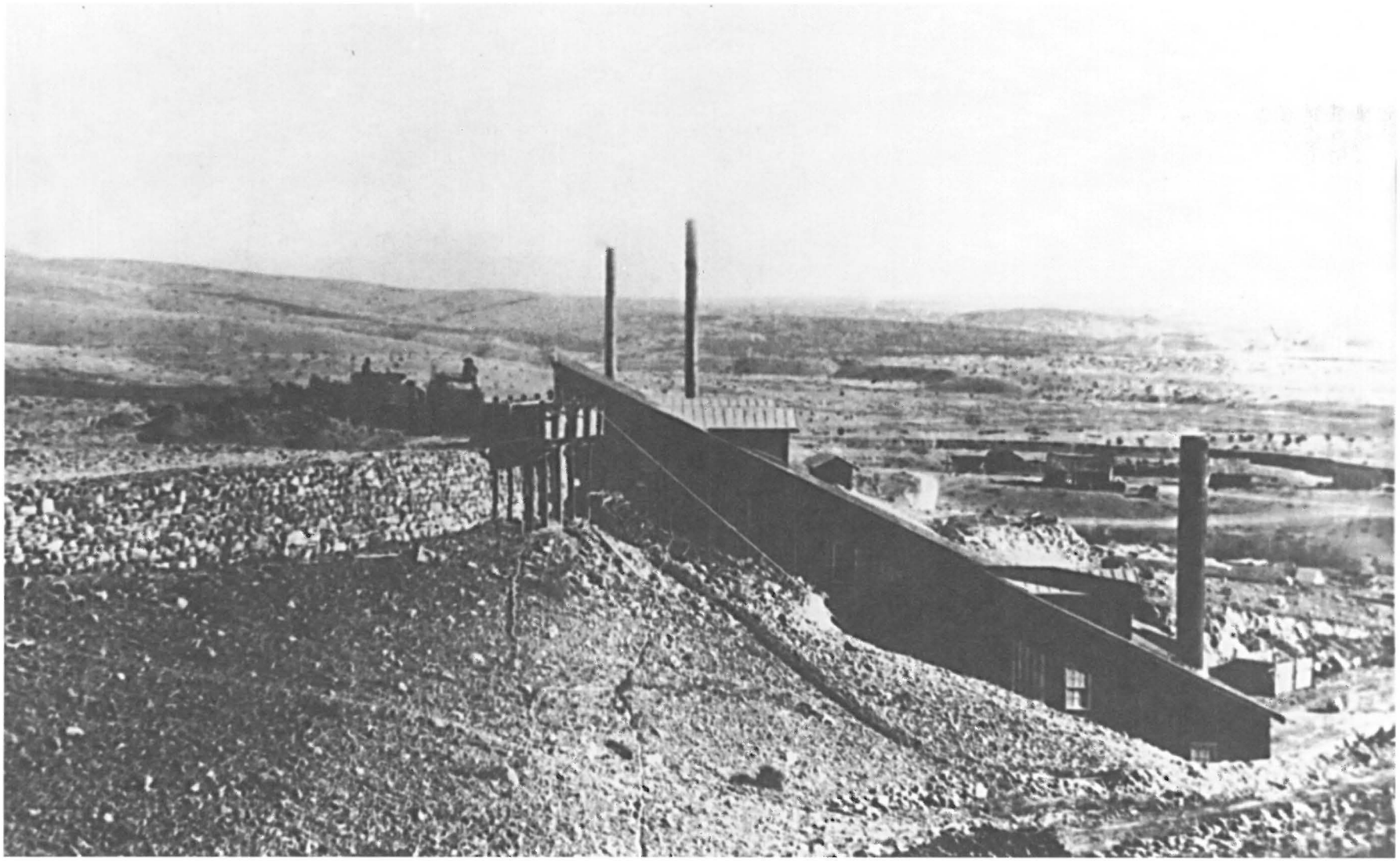
15. C. H. Aaron, "Notes on the Hydrometallurgy of Silver," California State Mineralogist *Eight Annual Report for the Year Ending October 1, 1888* (Sacramento, 1888), p. 849.

16. William F. Staunton, II, "Memoirs of William Field Staunton, II" MS in Staunton Papers, University of Arizona Special Collections. Quote from p. 46. Tombstone Mill & Mining Company annual reports.

17. John V. N. Dorr and Francis L. Bosqui, *Cyanidation and Concentration of Gold and Silver Ores*, revised edition (New York: McGraw-Hill Book Company, 1950), p. 3; Mining & Scientific Press, July 2, 1892.

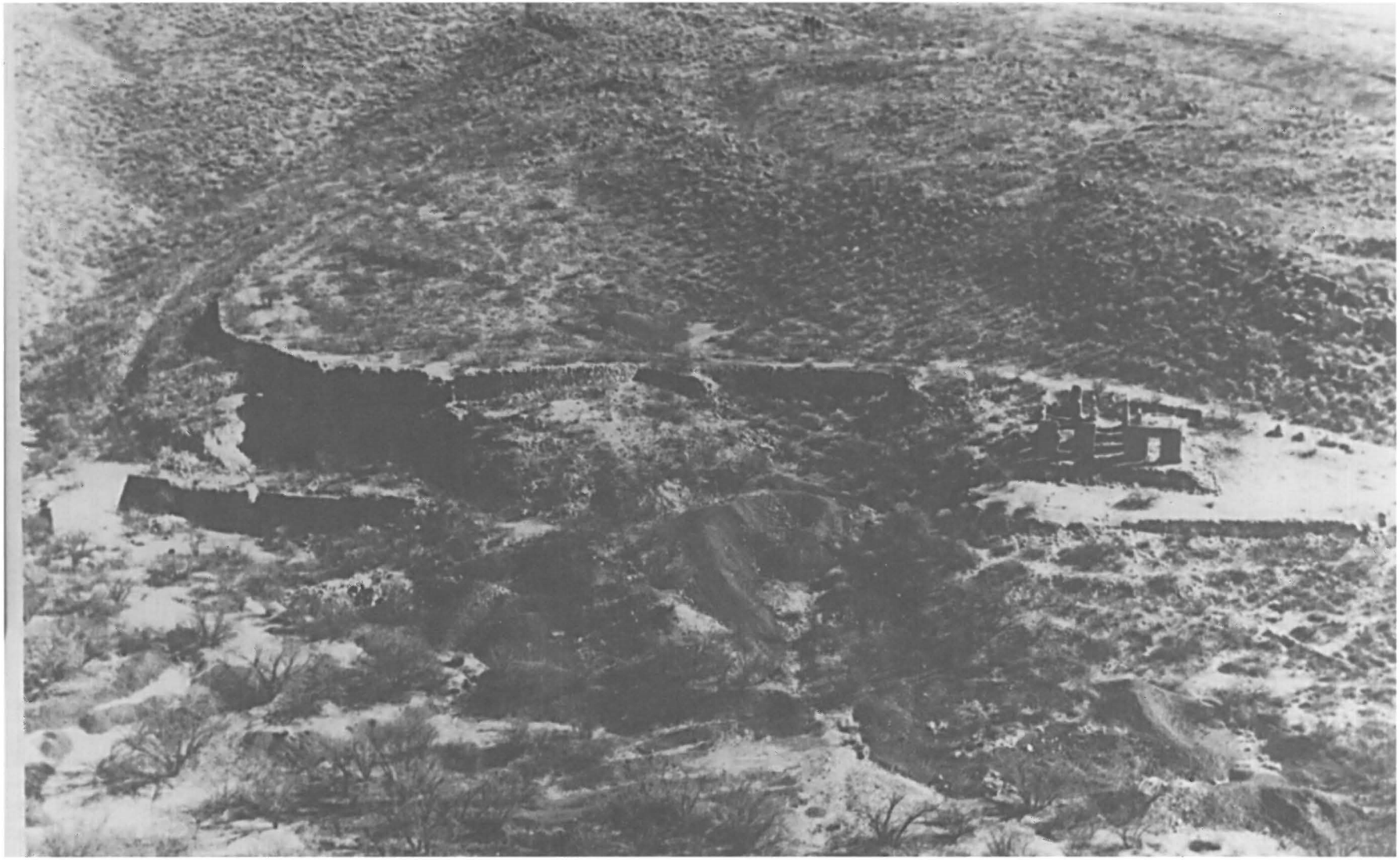
18. Robert L. Spude, "Cyanide and the Flood of Gold: Some Colorado Beginnings of the Cyanide Process of Gold Extraction," *Essays and Monographs in Colorado History*, Colorado Historical Society Essays Number 12 (1991), pp. 1-35.

19. Sam P. Davis, ed., *The History of Nevada* (Las Vegas: Nevada Publications, 1987 reprint), pp. 341-342; Jay A. Carpenter, Russell Richard Elliott, and Byrd Fanita Wll Sawyer, *The History of Fifty Years of Mining at Tonopah, 1900-1950* University of Nevada Bulletin, Geology and Mining Series No. 51 (Reno, 1953) pp. 46-47, 58; *Mining and Scientific Press* January 6, 1906, February 2, 1907, January 2, 1909, December 28, 1912; Jay E. Niebur and Jay E. Fell, Jr., *Arthur Redman Wilfley, Miner, Inventor, and Entrepreneur* (Denver: Colorado Historical Society, n.d.), passim.

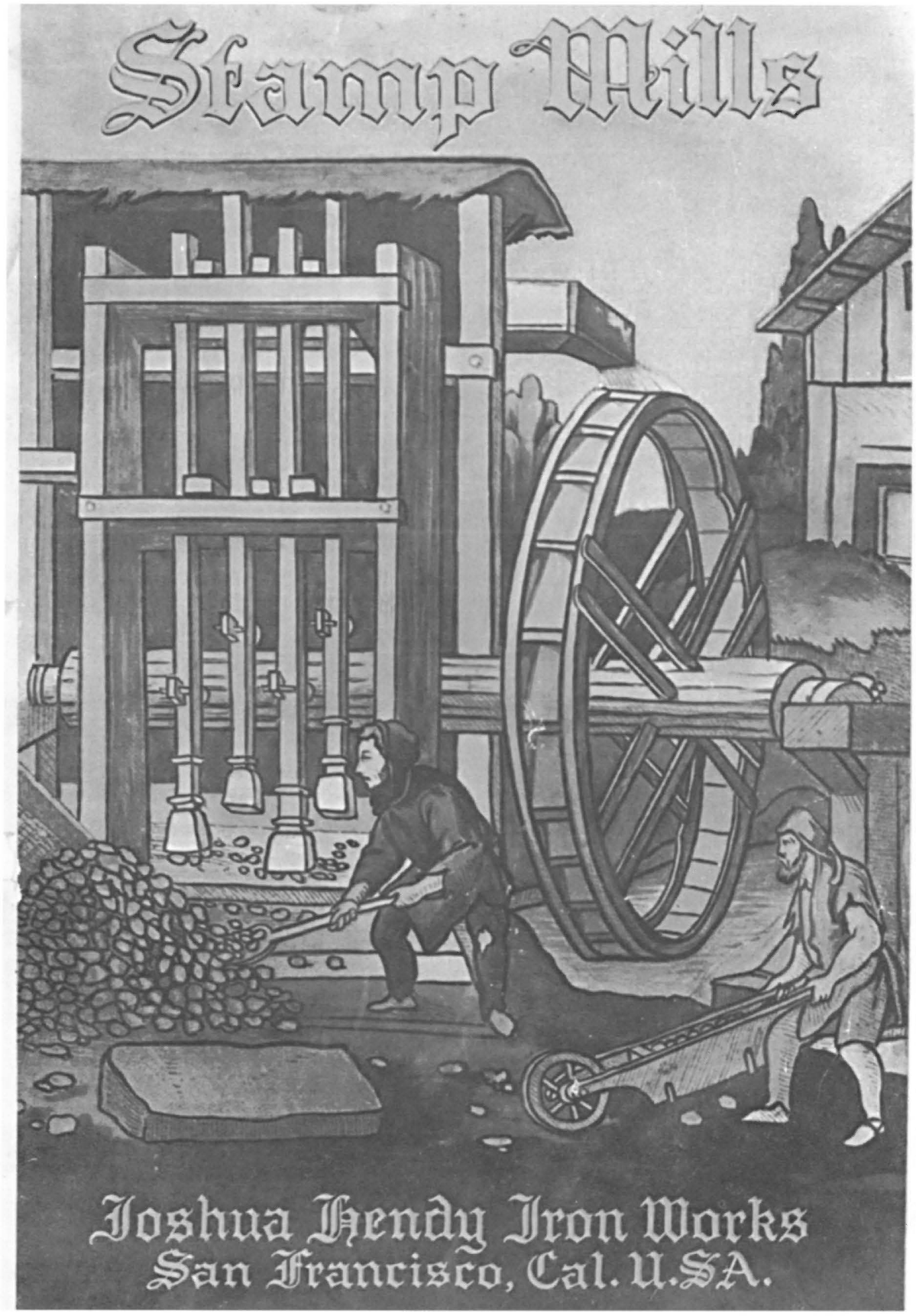


Charleston Mill, c 1880s. Wayne Winters Collection at Arizona Department of Mines and Mineral Resources.

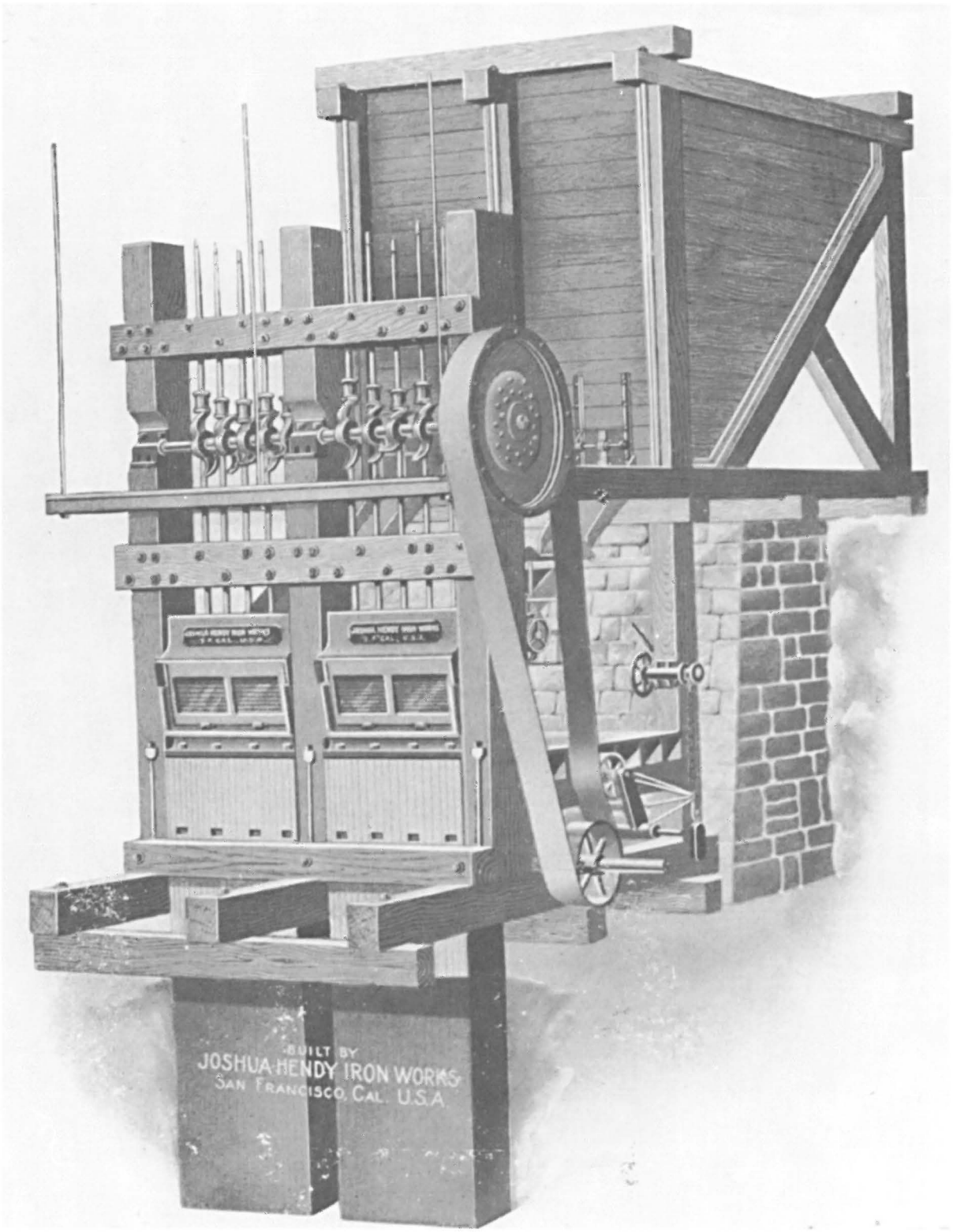
Remains at Charleston, c. 1960s. Wayne Winters Collection at Arizona Department of Mines and Mineral Resources.



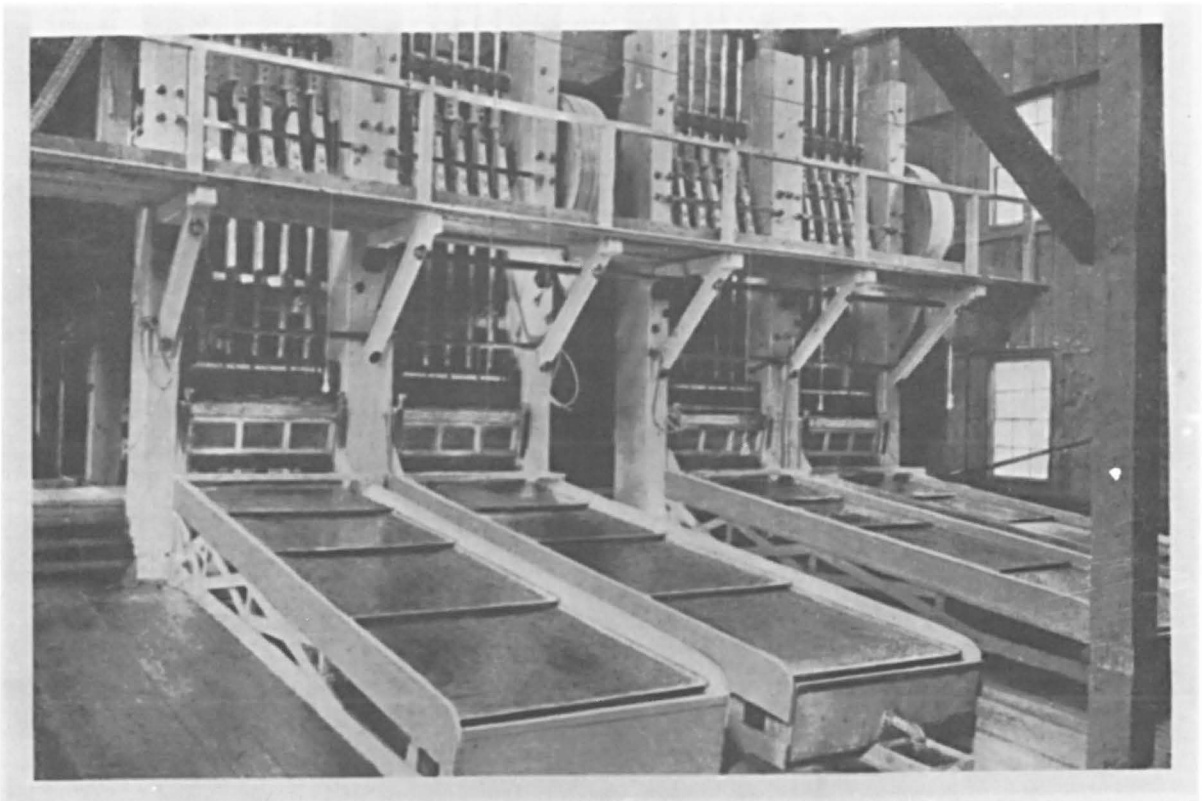
Charleston Mill Site, c. 1960. Wayne Winters Collection at Arizona Department of Mines and Mineral Resources.



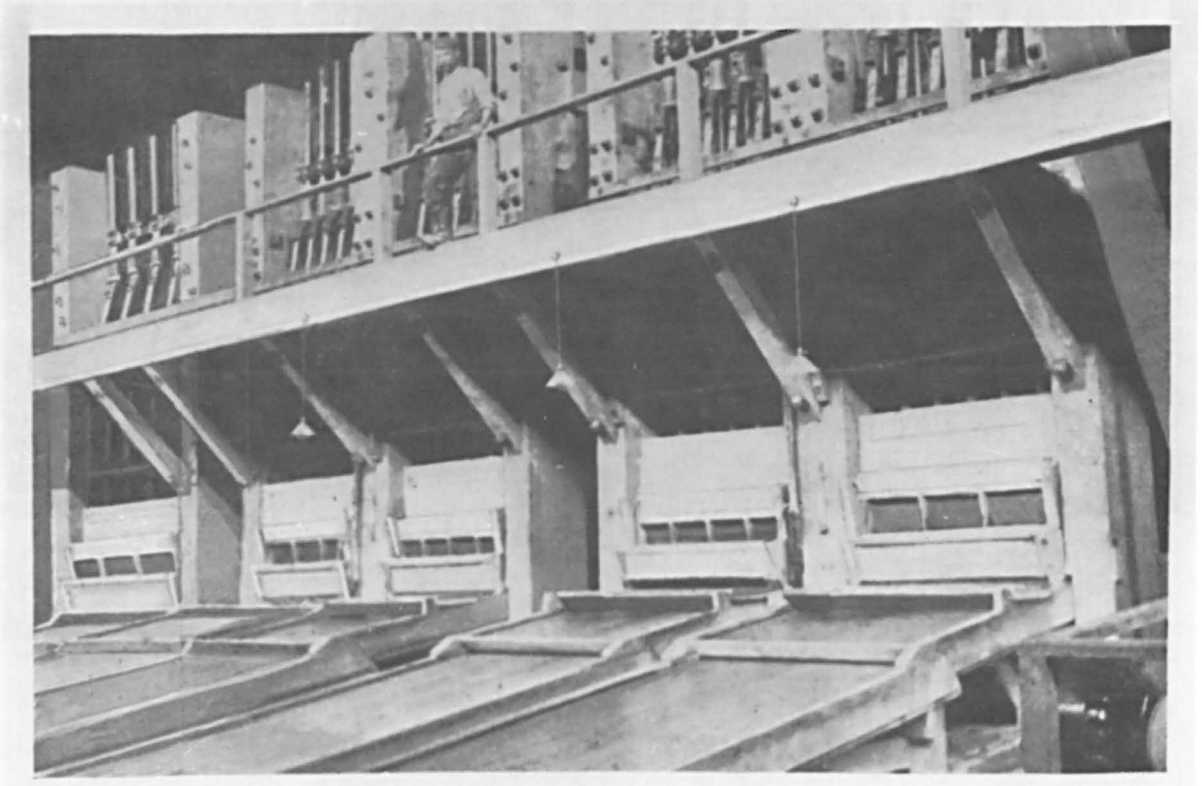
Stamp Mill, c. 1880. Courtesy of Arizona Department of Mines and Mineral Resources.



Stamp Mill, c. 1880. Courtesy of Arizona Department of Mines and Mineral Resources.



Twenty-Stamp Gold Mill, Arranged for Amalgamation and Concentration
Erected for Mt. Gaines Consolidated Mining Co., Mariposa County, Cal.



Five Battery Views of the Forty-Stamp Gold Mill at the Fairview Mine, Trinity County, Cal.

Stamp Mill amalgamation plate, c.1880s. Courtesy of Arizona Department of Mines and Mineral Resources.

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