HISTORIC KNIGHT FOUNDRY

A NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK

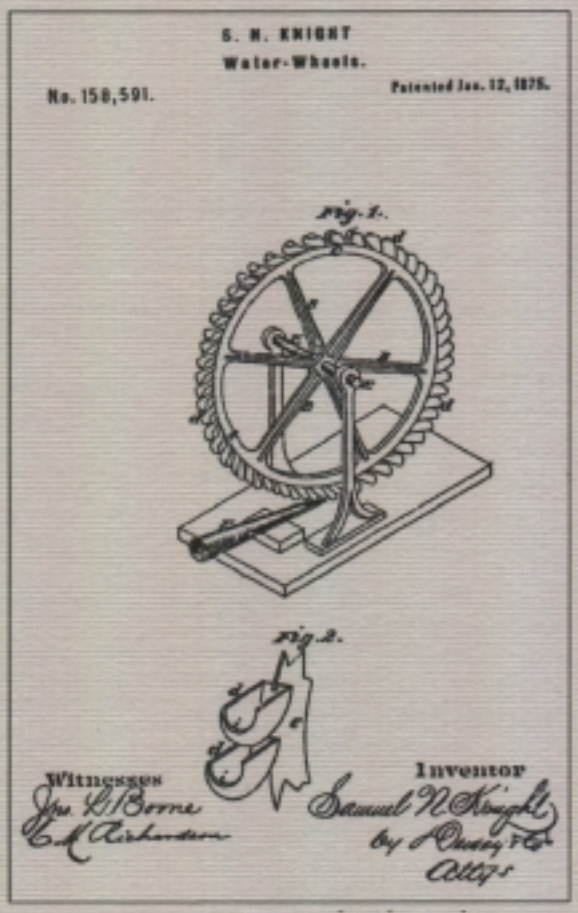
Water powered Foundry &
Machine Shop - Since 1873
Sutter Creek, California
Dedicated February 25, 1995

American Society of Mechanical Engineers

Historic Knight Foundry
A CENTER OF INNOVATION IN TH

There was a time when the foothills of California bustled with activity. The lure of gold, copper and other treasures sent men into the earth in droves, so that it often seemed there was more activity under the ground than at the surface.

Tools and machinery were needed to make the mining possible. Stamp mills, hoist works, pumps, ore cars, dredger buckets, rock crushers, and many other types of equipment had to be manufactured. If the mines were to operate, so must a foundry to cast the metal parts and a shop to machine them to final form. And this is where our story begins.



Patent drawing for water wheel with signatures.

Samuel Knight and crew circa 1895.

Historic Knight Foundry, in Sutter Creek California, is believed to be the only remaining water powered foundry and machine shop in the United States. Originally formed as Campbell, Hall & Co., the foundry was established in 1873 to better fill the ever growing needs of the Mother Lode mines, and to produce the patented Knight water wheel. Samuel Knight, a partner with Campbell and Hall at the beginning of their foundry venture, later bought them out with his new partner George Horne. Knight, a ship's carpenter, had worked at mine construction sites in Calaveras and Amador counties, where he had begun to develop a more efficient water wheel.

HISTORIC KNIGHT FOUNDRY

E MOTHER LODE

The Knight Catalog of 1896 gives a brief history of Knight's work:

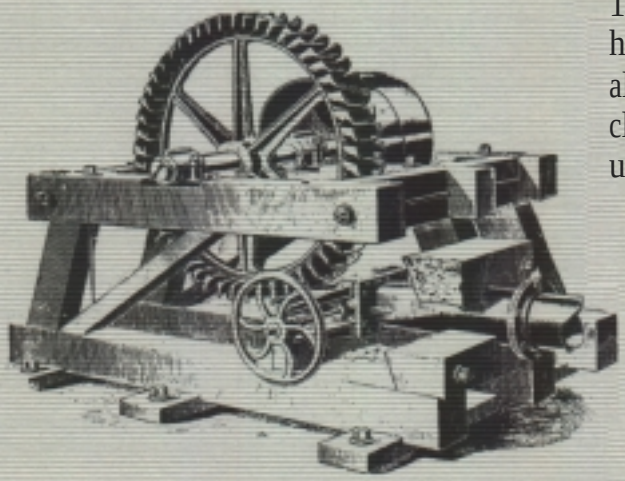
"About 1866, Mr. Knight, in common with others, made water wheels entirely out of wood. The buckets were shaped like saw teeth, and wooden flanges covered the sides of the bucket to confine the water; a round nozzle was used and the general results were considered at the time highly satisfactory."

"The next step (1868) was to make a wooden water wheel with iron buckets, giving them a curve and discharging the water toward the center of the wheel, still using a round nozzle."

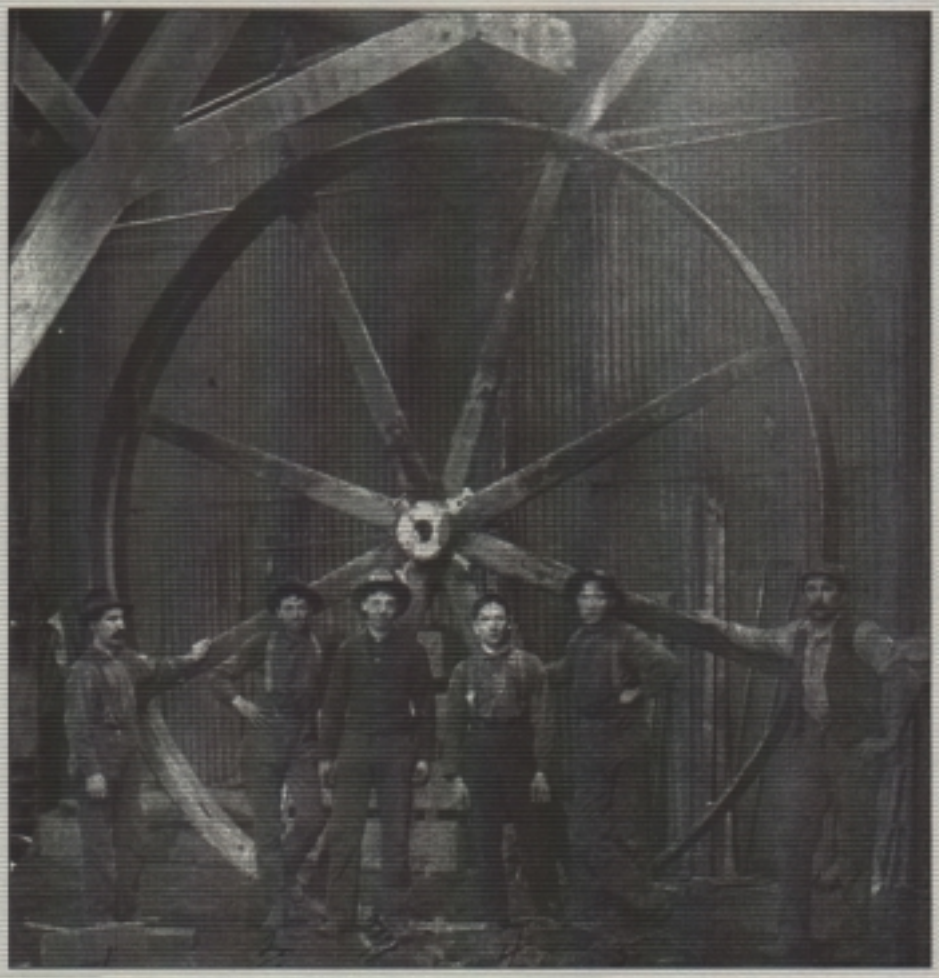
"In 1870 a man named Colman patented a wheel which had a bucket shaped very much like that of the present Pelton Bucket, the stream splitting and curving off to each side. He for lack of means did not develop the idea."

"Mr. Knight made several improvements in 1872 by using a curved iron bucket and having the discharge towards the center and to one side. Knight also found that the round nozzle did not fill general requirements. From these water wheels sprang the present Knight Wheel."

"In 1875 the first wheel of present design was placed at the Lincoln Mine at Sutter Creek, and from that time various improvements have been made in the size and arrangement of the slits in the nozzle and shape of the buckets, until at this present time, Mr. Knight is manufacturing a wheel that for general utility and economy, challenges competition."



The Knight Wheel: A technological breakthrough in the Mother Lode.

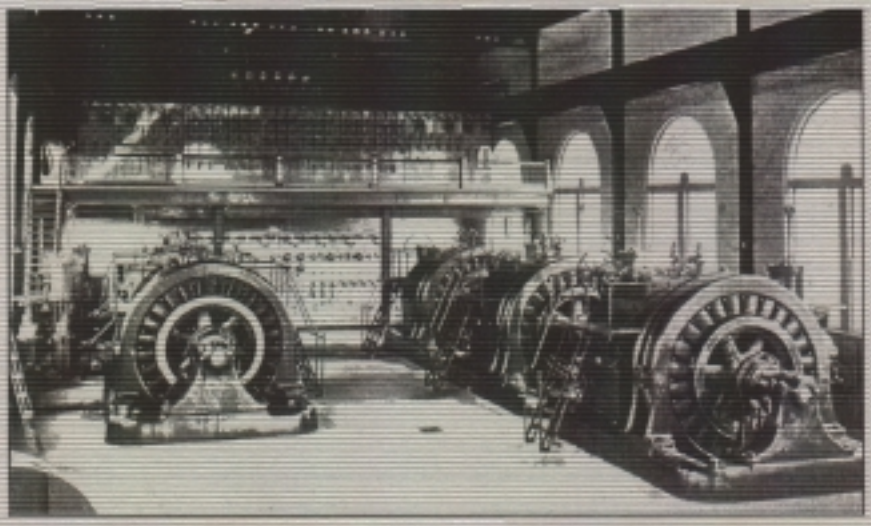


Cast iron pulley for a Sacramento ice plant ca. 1902.

Over a number of years Knight's work led to his patenting of a cast iron, high speed, water wheel which became the forerunner of the Pelton Wheel design.

The Knight Water Wheel catalogs of the 1890s show that more than 300 wheels had been produced and were in wide use all over the western United States. It was claimed that Knight wheels were being used to power over 2000 stamps in quartz mills. Knight also produced a water "motor" which was a small water wheel enclosed in a cast iron housing, ready to be attached to a high pressure water source.

After 1883 the Knight Water Wheel experienced heavy competition from the Pelton Water Wheel. Although Knight had been the acknowledged leader, Lester Pelton's design was being tried in northern mines of the Mother Lode and some felt it was a better design. In 1883 the Idaho mine in Grass Valley decided to settle the issue by inviting Knight, Pelton and two other wheel producers to Grass Valley to conduct tests of comparable wheels. During these trials, Pelton's design proved the most efficient, winning the contract to supply wheels to the Idaho mine. The Pelton Water Wheel Company went on to become the leading producer of impulse-type wheels, eventually moving its operation to San Francisco.



Power House at Ogden, Utah as shown in the 1912 Knight Catalog.

In a special mining edition of April 1897, written by G.A. Carpenter, the Amador Record newspaper produced the following overview of the Knight operation at that time:

The mines of the surrounding district are favored with one of the largest and best equipped foundry and machine shops in the state outside of San Francisco. The shop, located in Sutter Creek, is supplied with all the modern improvements and appliances for handling heavy work, such as is used in the mines. They have lathes that swing 10 feet in diameter, and a planer that takes in work 4 feet square and 16 feet long. Their rolls for sheet-iron work take in pieces 10 feet long and are strong enough to roll any thickness of Steel plates, having hydraulic appliances for handling them.

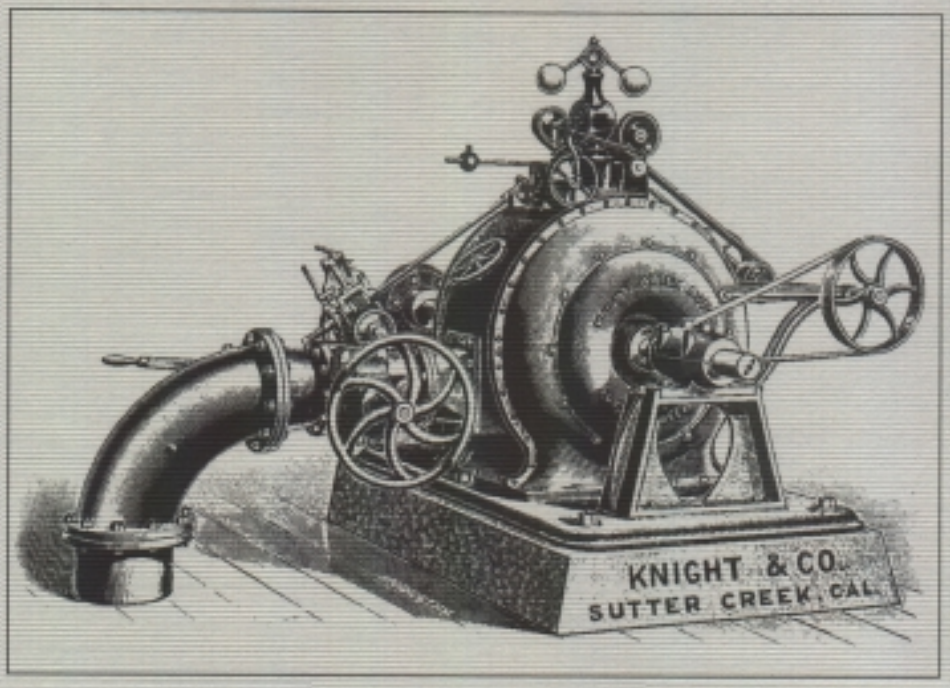
The works were started in 1873 on a small scale and have been gradually growing in size, until today the ground space which the works occupy, covers 16,658 square feet. The owners intend to erect, this year, another building for the purpose of manufacturing water wheel governors in connection with their water wheels, which have done so much to build their works. They have turned out this year the largest power plant in the United States. The first half of the plant is now setting up at Ogden, Utah. The water wheels are made of bronze and are 58 inches in diameter, and will be coupled direct to 5 of the General Electric Company 750 kilowatt generators, and will develop when in operation, 6,000 horsepower. The whole plant, when completed, is equal to 12,000 horsepower. The Pioneer Electric Company of Ogden, Utah, intends to transmit their electricity to Salt Lake City for lighting and power purposes. Each wheel is provided with two 6 foot flywheels that weigh 8,000 pounds, and are encased in a steel casing with the wheel. The casing is secured to a concrete foundation. All the gates are worked by hydraulic appliances as well as the nozzles, at the switchboard. The speed is regulated by Knight & Co. mechanical and electric governors, which keep the speed at all times within 2 1/2percent of normal.

The Knight & Co. works, of Sutter Creek, have been running day and night for the past four

Advertisement for Knight Wheel with governor.

months on principally water wheel work, and have employed 44 hands during the summer month

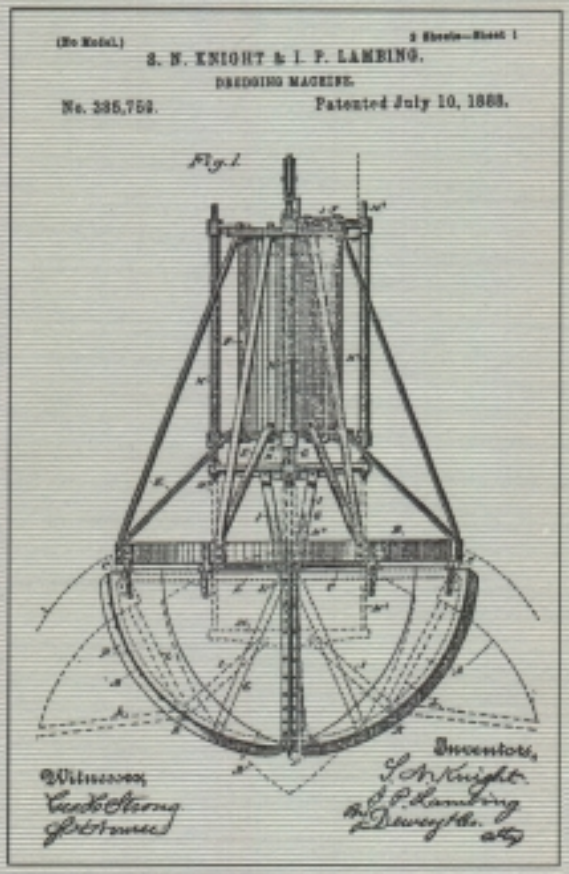
S. N. Knight, the senior member of the firm, is an acknowledged authority on water wheel power upon the Pacific Coast. It is he who first perfected and made practical the bucket wheel, and the other manufacturers, such as Pelton and Dodd wheels, were a modification and copy of the general plan of the Knight wheel. Today the wonderful power obtained from these wheels has made possible cheap motive power on the lode, and the owners of the many hoisting works and milk owe to his genius a debt of gratitude. Mr. Knight has keen perceptive powers and is quick to see an advantage for the improvement of all mechanism. Consequently his inventive turn of mind has brought about great changes in the utility of mining machinery, mills, and hoist plants. His late product, the electrical governor, which control the speed and regulates the supply of water on the immense Knight wheels, is a stride far in advance of all competitors. The Pioneer Electric Company at Ogden, Utah have introduced this late invention, and it is to



Knight & Co. of Sutter Creek, that the industrial world will turn now for a new lesson in the science of motive power, as obtained from the agent, water.

L. Oettinger, a progressive young man, is the other member of the firm, a valuable help mate in the management of this large enterprise.

The Knight Dynamo motor as shown in the 1896 Knight Catalog, This unit was in service at the Amador Electric Railway and Light Powerhouse in Sutter Creek.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S. N. KNIGHT & I. P. LAMBING.

DREDGING MACHINE.

No. 385,752. Patented July 10, 1888.

Fig. 1.

Witnesses,

Inventors,

Patent drawing for dredger bucket mechanism.

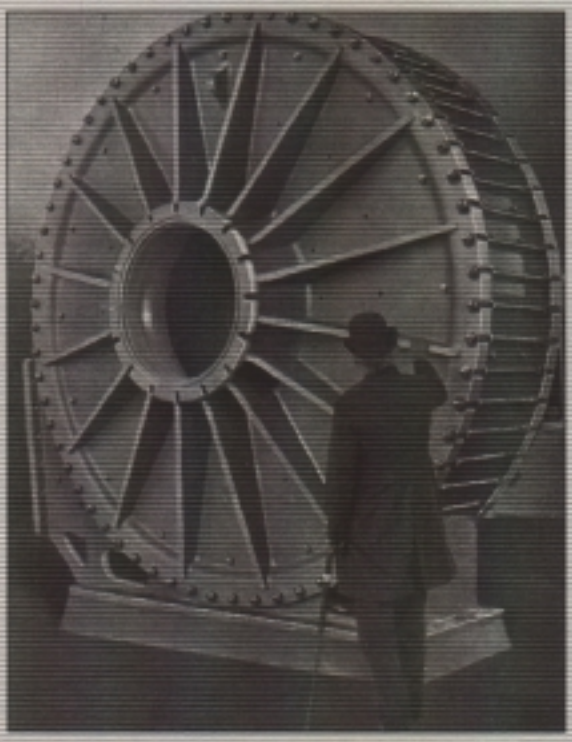
Knight continued to produce wheels into the early 20th century. Complete wheel and governor sets were supplied to some of the first hydroelectric plants in the western U.S., as discussed above. Others included were the White River project in Oregon and the Power, Transit and Light Company of Bakersfield.

Although it was no longer the prime producer of water wheels, Knight & Co. continued to flourish in the late 19th Century and early 20th as an innovative manufacturer of mining equipment, hydraulically operated dredger buckets, dredger pumps, hydraulic engines, speed governors and hoisting works. Knight & Co. held U.S. patents for seven different machines designed and produced in their shops.

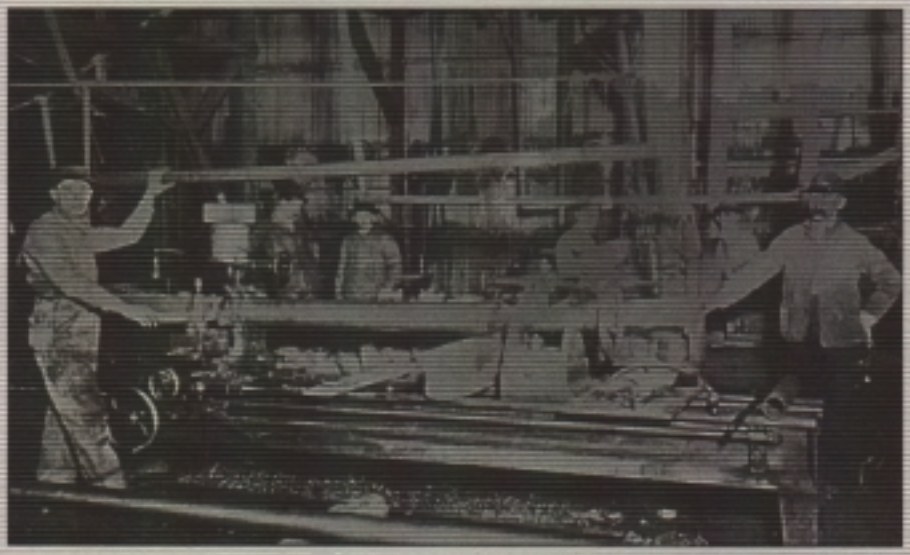
At the turn of the century Knight beat out several other large manufacturers to supply

large diameter dredger pumps for use in San Francisco Bay, Seattle harbor and the Willamette and Columbia rivers.

Samuel Knight died in 1913 and over several years the business was acquired by long-time employees C.H. Norton and D.V. Ramazotti. Ramazotti operated the foundry until the late 1940s. One more piece of equipment was produced after Knight's death for which the foundry would receive a patent. This was the Knight Scarifier developed in 1928. This machine was an early day road ripper for taking the heavy ruts out of dirt roads which developed from heavy use or wet weather. The Scarifier was sold nationwide with some being exported to Central and South America, and several going to Africa.



Samuel Knight with 30-inch 2000hp dredging pump built for the port of Portland, Oregon.



Water-powered machine shop in full operation.

For the fifty years from the early 1900s to mid-1950s, the foundry not only continued producing mining equipment for the gold mines of the Mother Lode but, also became an important producer of machinery for the timber and lumber industries. Knight Foundry produced some of the original equipment installed in the saw mills of the central California foothills and later supplied replacement parts and repair facilities. Knight Foundry has counted most of the major lumber and timber operations in northern and central California among its customers and, in more recent years, clay, sand, gravel and gold dredging operations. The foundry was taken over in the late 1940s by Mr. Herman Nelson, who operated the plant until his death in 1970.

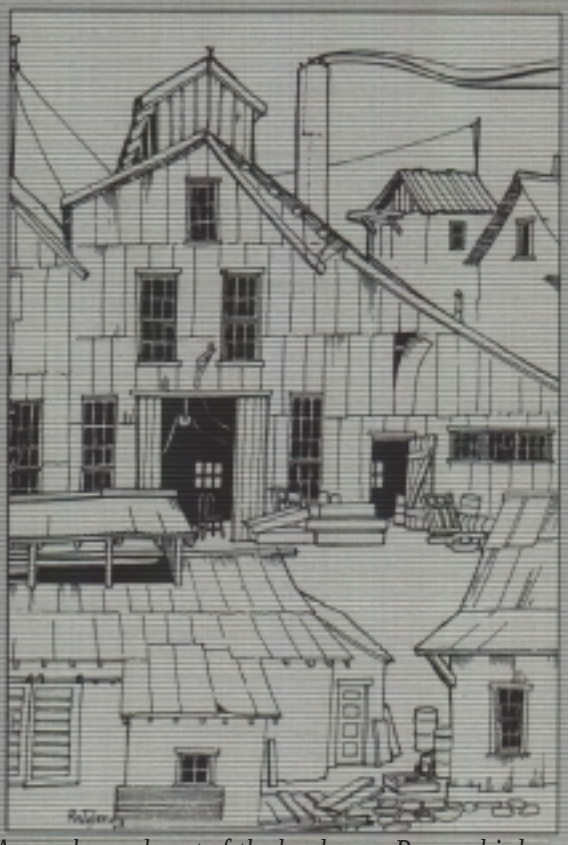
From 1970 to 1991, in addition to supplying new and replacement equipment to the mining and timber industries, it produced machine parts for other manufacturers of pumps and agricultural equipment. It also produced reproduction architectural iron work for the California state capitol restoration and restoration projects in Old Sacramento. During this period the foundry was owned and operated by Carl W. Borgh.

Sutter Creek: ALWAYS A FOUNDRY TOWN

Sutter Creek has always been a foundry town. The first foundry in Sutter Creek was operated by Coffin, Hitchings & Co. and was part of the Amador No. 2 stamp mill operation located on Spanish Street. By mid 1854 the foundry had moved up the creek several hundred yards and was operated by Frank Tibbits, previously the superintendent at the Lincoln mine. This foundry was located at the intersection of Highway 49 and Badger Street, formerly known as Foundry Street. It appears there was a real need for the services provided at the Tibbits' Foundry, as he rapidly expanded the scope and products of his plant. Tibbits died in 1869 and the works were sold to S.S. Mannon. At some point Mannon's became Donnelly's Foundry. Donnelly's Foundry survived into the 1870s and even overlapped with the Knight Foundry. Thompson & West (1881) tells us that the Donnelly works were at this time water-powered and that water turbines, commonly referred to as "water wheels" were one of their specialities.

Donnelly's Foundry: Workers display their wheel design (right), nozzle (center), and large wheel (left background).

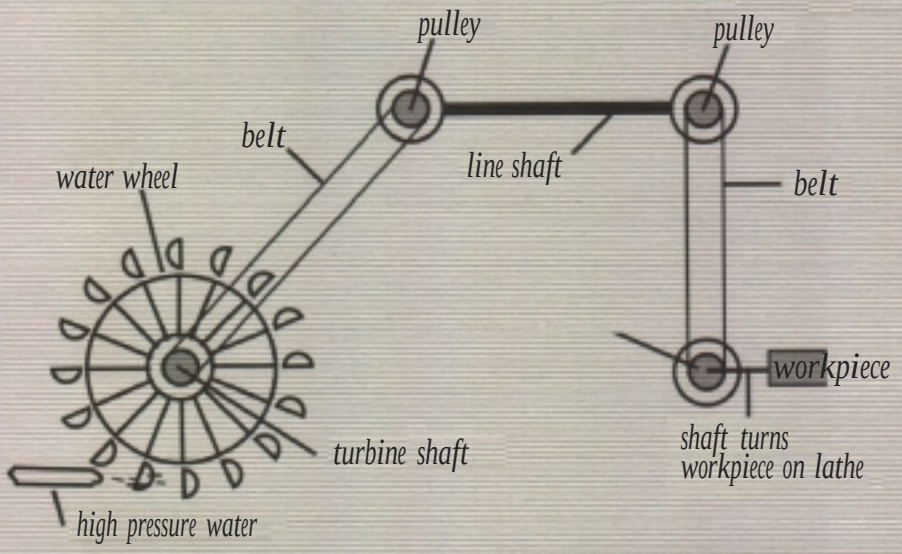
Other foundries developed in the Mother Lode at about this same time. One of the earliest was D.C. Demarest's Angels Iron Works in Altaville, near Angels Camp. Established in 1854 the foundry continues to operate today as California Electric Steel. I t is the oldest operating foundry west of the Mississippi. Other foundries grew up in Sonora, Placerville, Grass Valley, Nevada City and Downieville. Larger foundries and equipment producers such as Joshua Hendy Machine Works, the Union Iron Works and Risdon Iron Works were established in San Francisco.



An unchanged part of the landscape. Pen and ink study of Knight Foundry by R.W. "Toby" Tyler.

Knight Foundry Today

Knight Foundry continues to function as a foundry and machine shop, producing gray iron castings of every description for industrial and individual customers. Still using the 42-inch diameter wheel installed by Samuel Knight in the 1870s, the machine shop is powered by water falling over 400 feet from the ridge above Sutter Creek. The Tanner Reservoir which supplies water to Knight Foundry was built in the late 1870s as part of the Amador Canal to supply water power to the mines of central Amador County. The Amador Canal, through a system of wooden flumes, ditches, and man-made lakes, carried water over 50 miles from the Mokelumne River to ensure a dependable year round power supply. Apart from the main water wheel, small wheels throughout the site operate other machinery. A 24-inch wheel drives the air compressor and originally was used to power the blower for the air supply to the cupola furnace in the foundry room. Two 12-inch water motors power lathes and the table saw in the pattern shop. An 18-inch motor powers the planer in the machine shop. A 12-inch motor drives the grinder in the foundry; and others run the tumbler, the clay processing mill, the hoist for the drop ball, and the firewood table



Knight Foundry ca. 1980.

Knight Foundry, listed on the National Register of Historic Places and designated as a California Historical Landmark, operated continuously as a commercial foundry until 1991, when the owner reduced operations due to sagging economic conditions. In July 1992, Historic Knight & Co., Ltd. began developing programs both to keep the foundry operating and to promote historical tourism and educational uses related to the site.

In 1993, Friends of Knight Foundry, a non-profit organization, was formed to assist in these efforts. It has begun to develop a long range plan for acquiring, operating and preserving the site; and to begin fund raising activities.

Today, Historic Knight Foundry, under the direction of Ed Arata, offers a self-guided tour to visitors on a daily basis. Visitors receive a walking-tour-guide that leads them through 20 stops along the tour route, explaining the history and

HISTORIC KNIGHT FOUNDRY

operation of the site. Guided group tours are also available by reservation. In addition to tours, schools are encouraged to use the site for field trips. The California History and Manufacturing Technology Tours offer several programs. A l-1/2 hour tour covers a tour of the foundry, time with the blacksmith, and a hint of what life was like in 19th century Sutter Creek. An all-day tour includes not only the foundry but visits to the Kennedy Tailing Wheels and the Amador County Museum. This program gives students a better grasp of how mines in Amador County operated and why Knight Foundry was needed to supply heavy equipment.

Knight Foundry has also developed a three day "hands-on" workshop for adults. The Industrial Living History Workshop, advertised nationwide, has been well received. Students actually work in the foundry, machine shop, blacksmith shop, and pattern shop to learn the skills of the late 19th century. The class regularly has twenty-one to twenty-eight students, working in groups of seven. At each work station students receive a brief introduction to the craft and are then given an opportunity to practice these hand skills under the direction of experienced instructors. Students are encouraged to bring foundry projects with them; these may be molded and cast as part of the workshop. In the foundry, students receive instruction in the basic skills of green-sand molding; they then mold several items. In the machine shop, students are introduced to water-powered machine tools and then given an opportunity to operate the lathes, planers and radial-arm drill press. The blacksmith portion gives students the chance to do forge work while producing several items. Students learn the basics of pattern making in the pattern shop and finally are shown how the cupola furnace is prepared and fired for a melting operation. During the final session, those students who wish to participate may also step in with the foundry staff to pour some iron castings.

Molten iron on its way to becoming a casting.

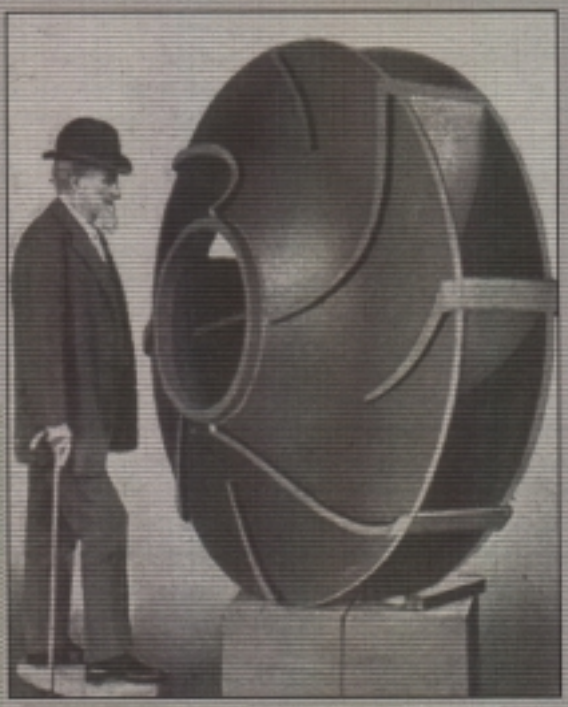
During recent workshops, students from all walks of life have come to Sutter Creek to experience turn-of- the-century technology. They have produced castings for gas engine, steam engine, and locomotive restoration projects, as well as some pieces of art.

New programs are also in development. Industrial Living History Workshops will be offered to college students interested in preservation, history, engineering, technology and/or foundry management. And a docent program will encourage volunteers to help preserve the site and to experience what it was like to live and work in a small community like Sutter Creek, at the turn-of-the century.

In the future with the help of volunteers from throughout the country, Friends of Knight Foundry hopes to preserve Knight Foundry for future generations and to a continue to create innovative history, technology, foundry and manufacturing programs for young people and adults.

Samuel N. Knight
(1938-1913)

Samuel N. Knight was born in Brunswick, Maine. He was apprenticed as a ship's carpenter at age 14. Upon completing his journeyman training he left Maine and that trade to work in Florida in a machine shop. In the early 1860s, at the start of the Civil War, Knight returned to the Boston area and shortly thereafter booked sea passage to California aboard the Garibaldi. He arrived in San Francisco in 1863 after spending five months at sea and eventually made his way to the mines in Calaveras County. He worked as a millwright constructing mine structures and over time moved to Butte City, then Jackson and later to Sutter Creek.



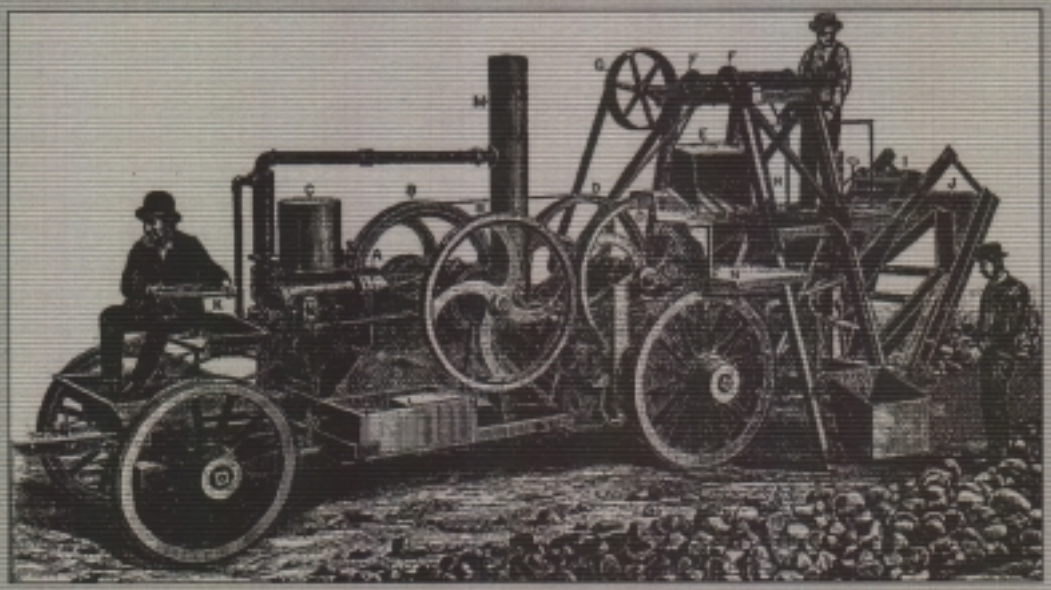
S. N. Knight shown with 6-foot diameter pump impellor for a San Francisco dredger pump.

One project he took on for the new county of Amador was the construction of wooden bridge over Sutter Creek to carry the increasing wagon traffic on the north-south road, now Highway 49.

Knight had been called on to build a number of large- diameter wooden water wheels for the mines of the area, but these proved to be unsatisfactory for California conditions. Knight experimented with high-pressure wheels and eventually patented his design in the early 1870s.

Samuel Knight died of pneumonia in 1913 and was buried at Sutter Creek. He left a portion of his estate to his sister in Maine, but a major portion of the foundry operation was left to the employees.

Prototype self-propelled rock crusher for surfacing roads, S.N. Knight at the wheeel.



HISTORIC KNIGHT FOUNDRY

THE HISTORY AND HERITAGE PROGRAM

The ASME History and Heritage Recognition Program began in 1971 as part of the Society's effort to note, document and acknowledge mechanical engineering achievements of particular significance.

The Program is overseen by the History and Heritage Committee, which includes mechanical engineers, historians of technology, and the immediate past curator of mechanical and civil engineering at the Smithsonian Institution.

An ASME Landmark represents a step in the evolution of mechanical engineering and reflects its influence on society here and abroad. This Landmark is one of many throughout the world that are a part of our engineering heritage.

The Knight Foundry site is recognized as an ASME National Historic Mechanical Engineering Landmark. In addition, 46 International, 16 Regional and 117 National Landmarks, Collections, and Sites have been recognized.

NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK

Knight Foundry, Established 1873

This is one of the nation's earliest foundry-machine shops remaining in operation and one of the few water powered. It was founded by Samuel N. Knight (1838-1913) to manufacture machinery for the gold mines of the Mother Lode region. Knight was one of several inventors experimenting with impulse turbines to exploit the areas abundant high-head water power for driving hoists, ore stamps, and other mining machinery. He patented an efficient "water wheel" that came to dominate the field prior to the introduction of the Pelton turbine in the mid-1880s. Knight turbines drive some of the machinery of the works.

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REFERENCES

"Knight Foundry History" by Ed Arata, 1972.

"Sutter Creek- Logan's Alley" by Larry Cenotto, Cenotto Publications, 1988.

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