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## THE MILLS OF ANGELS

BY EDWARD C. LEONARD

It is now a half-century since the great quartz mills of Angels Camp have been still. The huge structures were razed years ago, and all we can see today are crumbling foundations. But there are still a number of people in the community who remember vividly the roar of countless dropping stamps as the tons and tons of quartz ore were crushed to liberate the gold and "sulphurets."

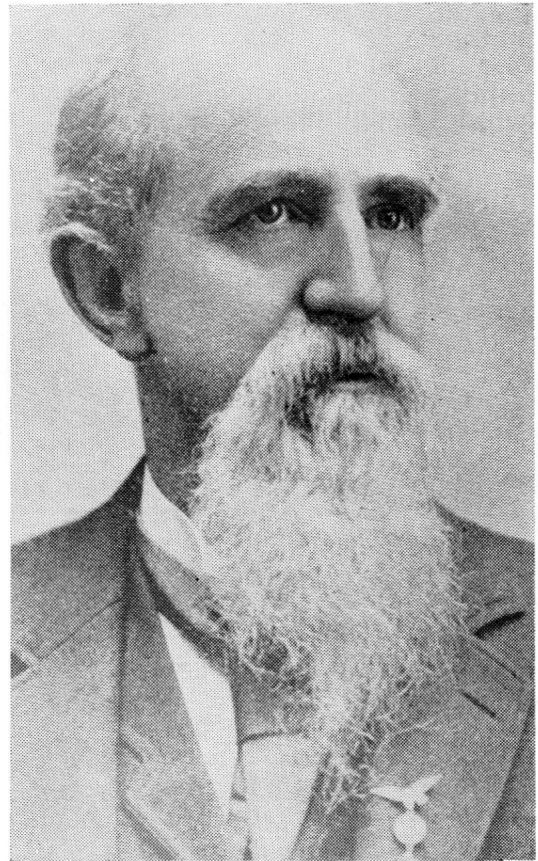
There were a number of stamp mills on the outskirts of Angels Camp, and in fact, in many places about the county. Many of these were erected in hope and haste and crushed but a small amount of ore before they were abandoned. But it is those mills that roared on, day after day, year after year, pounding out millions in gold, that we are interested in—the Utica, Stickles, Gold Cliff, Madison, Lightner, Angels, and Sultana, as well as the big Chlorination Works that extracted the precious gold from the tight grip of the sulphide minerals, and the Blanket Plant that squeezed the remaining values out of the slime tailings.

Ed Leonard is one of those who remembers the mills, and he reconstructs here for us the important part they played in Angels Camp history. Readers will recall Mr. Leonard's excellent description of "Early Mining in Angels Camp" in our October, 1968, issue.

### Consolidations of the Early Claims

The first lode mining boom, which began in 1854 with the discovery of the Davis-Winter vein in Altaville, held but a short life for many of the original locations. The immense lode was low in grade, with much of the gold value locked up in pyrite and other sulphide minerals. This ore, once the sulphide zone below the weathered outcrops was reached, could not be worked on a paying basis with the inefficient mills of that day. A few of the mines contained enrichments (called ore shoots) near the surface, and these mines were able to continue working as long as they were in good ore. The Maltman was the only mine that had a continuous operation during this early period.

By 1866, the Crystal, Lightner, and Utica claims were abandoned by their first owners. James G. Fair, (later of Comstock Lode fame) and others relocated the Crystal on



CHARLES D. LANE

Probably no one individual was more responsible for the success of Angels Camp lode mining than Charlie Lane. Possessed of great courage and much self-confidence, he put the complex Utica operation together, with the financial help of Alvinza Hayward and Walter S. Hobart, and managed it for a number of years. He placed most of his Utica-based fortune, however, into an ill-fated Alaskan mining venture.

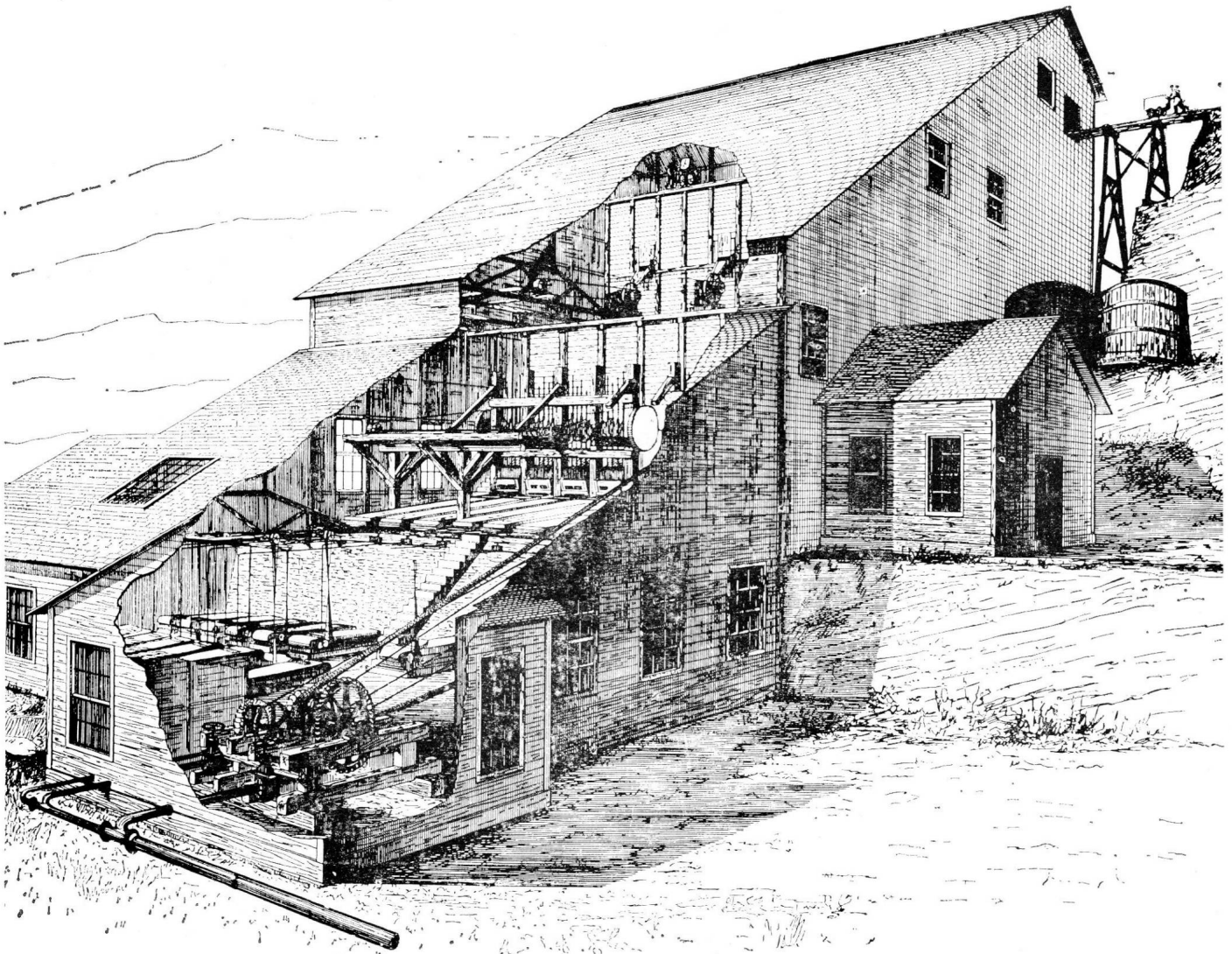
—Courtesy of  
the Stuart Library, Univ. of the Pacific.

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February 22, 1866. Robert Leeper and associates relocated the Utica on January 26, 1869. The Lightner was not thought worthy of relocation until Z. T. Carlow filed on it on August 24, 1885.

Meanwhile, Bovee had purchased the Winter Bros. and Fritz mines in '65, and thus made the first consolidation. This property never remained idle for any length of time during Bovee's ownership. The Dr. Hill and Potter mines were active during the early period, though not on a continuous basis. The Union Mining Company worked the Stickles mine prior to its sale to Captain Nevills in 1885. Likewise, Robert Leeper reactivated the Utica and operated it until selling out in '84.

Angels Camp mining really came to life in the 80's. During 1883, the Marshall Mining Company, with Captain Cushing as superintendent, began new development at the



#### FORTY-STAMP MILL

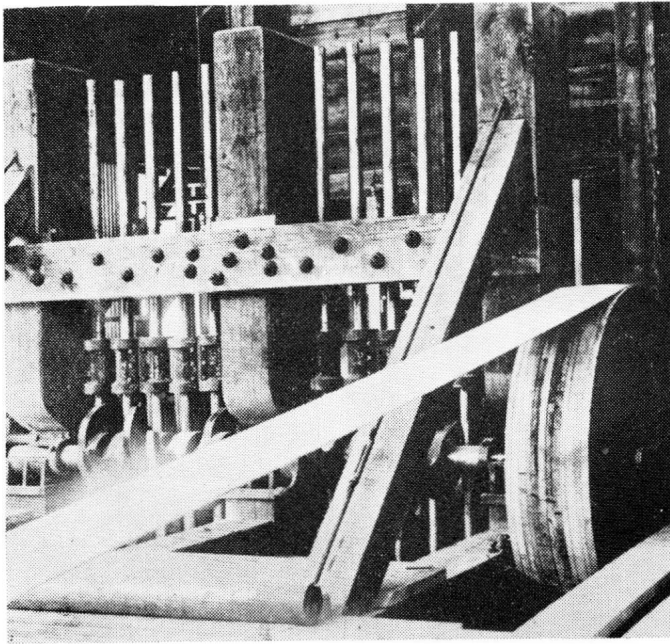
This is a typical quartz mill. The hand-trammers are delivering ore to the crusher bins on the top deck. The crushers, on the next deck down, discharge the crushed ore into the mill bins. The stamps are mounted on the middle deck, and the amalgamation plates may be seen in front. On the lower deck are the Frue vanners. In the extreme lower right corner of the mill building are the water wheels. These provide the power trans-

mitted by a complex arrangement of shafts and belts to each piece of machinery requiring it. The reader who wishes to delve deeper into the intricacies of the design and operation of a stamp mill should read "The Milling of Gold Ores in California," by John Hayes Hammond, in the Eighth Annual Report of the California State Mineralogist, from which this illustration has been taken.

Bovee, later renamed the Sultana. A new mill was constructed and the shaft deepened. In 1884, C. D. Lane purchased Leeper's Utica properties. F. K. Bechtel bought the Stickles in September of that year and sold it to Captain Nevills five months later. James V. Coleman, nephew of W. S. O'Brien (one of the Big Four of the Comstock) purchased the Angels, Potter, and Dr. Hill mines in 1884, which was the second consolidation. Then Captain Nevills sold the Stickles to the Utica Mining Company in April, '89, for \$250,000.

The mines on the lode were now consolidated into three

ownerships, and called the Sultana, Angels and Utica. Although the Lightner claim was relocated in 1885, it was not until 1896 that real development began there after Alexander Chalmers, of Stockton, took over. This brought the number of operating companies to four. None of these companies could have operated successfully if they had not built large plants capable of milling great tonnages of the low-grade ore. At the height of mining activity in Angels, a total of 320 stamps were dropping. These mills recovered more than \$25,000,000 in gold before closing down in the 'teens and early twenties.



**TEN STAMPS**

A detailed view of the upper part of a double battery of ten stamps. The cams may be seen on the cam-shaft. The stamps have been raised on the fingers (not visible) so that the mortars (below this view) may be cleaned up. The tappets normally rested on the cams, when the stamps were operating, so that the stamps were raised, rotated, and dropped. —Courtesy of the Stuart Library, Univ. of the Pacific.

## The Quartz Mills

The first quartz mills built in the Angels district were described in my earlier article. These were small, with light stamps, and adapted only for relatively low tonnage operations. Most of these had less than 20 stamps. They were gradually replaced with larger and more efficient mills. These were sometimes supplemented with a number of arrastras, for which Angels Camp was well known. But the recovery of gold, even so, was poor as compared to that of the later, more modern, mills. In the early days the sulphide concentrates were not saved.

The power necessary to run the first mills was furnished by overshot water wheels. As the mills became larger, steam power was resorted to, although this required tremendous quantities of cordwood. In fact, the Utica switched from steam power back to water in '89, when they had developed an adequate supply of water through their own ditch system after buying the Union Water Company. In 1899, electric power became available, generated by the Utica Company and the Standard Electric Power Company, and all the mills eventually converted over to this more convenient source.

The Marshall Mining Company installed a modern 20-stamp mill in 1881 on the east side of Main Street, across from the Sultana shaft. In 1902, the Sultana Company increased this to 40 stamps.

William Maltman erected a 30-stamp mill on his claim in 1866. This mill was abandoned later, and a new 40-

stamp plant built near the Potter shaft in '91, with 16 Frue vanners, by the Angels Mining Company, with a capacity of 200 tons per day. The foundations can still be seen across the highway from the Angels Museum.

The Lightner Company in 1897 erected a 40-stamp mill across the gulch on the west side, and the next year added 20 stamps more with 36 Frue vanners.

Robert Leeper had a 20-stamp mill on the Utica when he sold out to C. D. Lane. Forty more stamps and 24 Frue concentrators were added in '88 to this mill, just south of Utica Park. When the Cross shaft was completed in 1903, this mill was moved over next to the Stickles mill.

In 1886, Captain Nevills built a 20-stamp mill near the present Angels power plant. Two years later the 40 stamps at the Ilex mine, near Mokelumne Hill, were purchased and moved to the Stickles mill. The following year this 60-stamp plant became part of the expanding Utica operation.

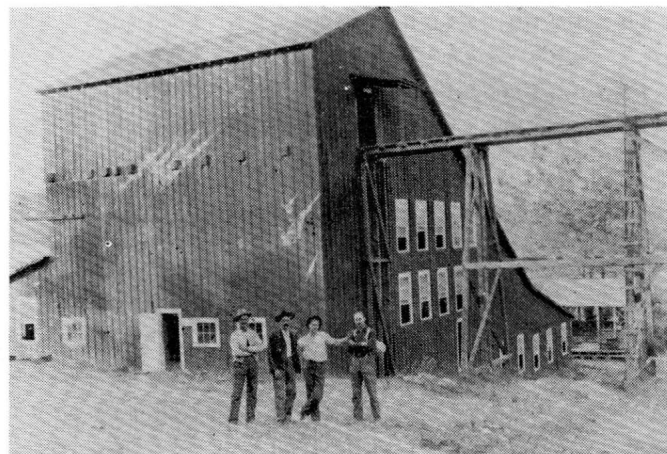
A. J. and T. M. Lane, sons of C. D. Lane, were operating a 10-stamp mill on the Madison in '92. Shortly thereafter they increased it to 20 stamps. In May of '94, the Utica Company reconstructed the mill adding 20 more stamps, 4 Tullock and 12 Frue vanners. This mill was powered by a double turbine water wheel.

In 1887, the Gold Cliff Mining Company erected a new 20-stamp mill on their property. When the Utica Company took over the Gold Cliff, they used this mill, situated on the east side of Bunker Hill. In 1910 they moved 40 stamps from the Utica-Stickles mill and built a new plant for the Gold Cliff west of the old mill.

At one time the Utica Company was operating 180 stamps and 76 vanners in the four mills under their management. At this time, mill-men were paid \$3 for a 12-hour shift and worked seven days a week.

## The Milling Process

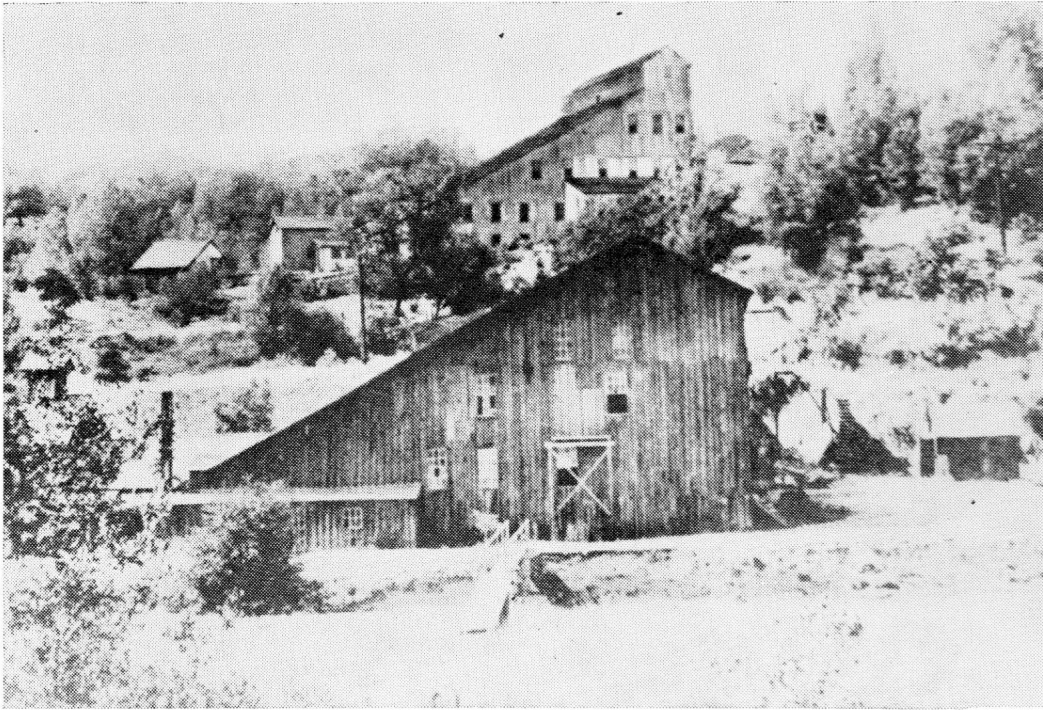
The process of milling the ores to recover the gold may best be explained by describing the Utica mill. Please refer to the cut-away drawing of a 40-stamp mill, and the photograph of a typical 10-stamp, double battery.



**THE SULTANA MILL**

Containing 40 stamps, this was one of the smaller quartz mills at Angels Camp.

—Angels Boosters Club Collection



#### GOLD CLIFF AND MADISON MILLS

The upper mill is the old 20 - stamp Gold Cliff plant. Later, 40 stamps from the Utica - Stickles mill were moved over to a site west of this, to mill the low-grade ores from the Gold Cliff mine. The Madison mill is in the foreground. The Blanket Plant was just to the right of this view, which was taken on the Angels Creek, about one-half mile below the highway bridge.  
—Angels Boosters Club Collection.

The ore was crushed at the collar of the shaft and then trammed to the mill and stored in a series of bins. At some mills, the crusher was installed within the mill building. A Challenge automatic feeder at the base of the ore bins fed each battery of stamps. A battery generally consisted of five stamps, operated by a cam-shaft driven by a flat belt over a wooden drive wheel. Commonly, two batteries were driven by one cam-shaft, and in some

instances single shafts served even more.

The stamps, each weighing 835 pounds, were raised by a cam attached to the shaft, and were dropped seven or eight inches about 100 times a minute. The cams were S-shaped and raised the stamps twice on each revolution of the shaft. They were set at various positions, so as to drop the stamps in a pattern of 1-4-2-5-3-1 for a five-stamp drive, and 1-5-9-7-3-2-6-10-8-4-1 for a double battery, the

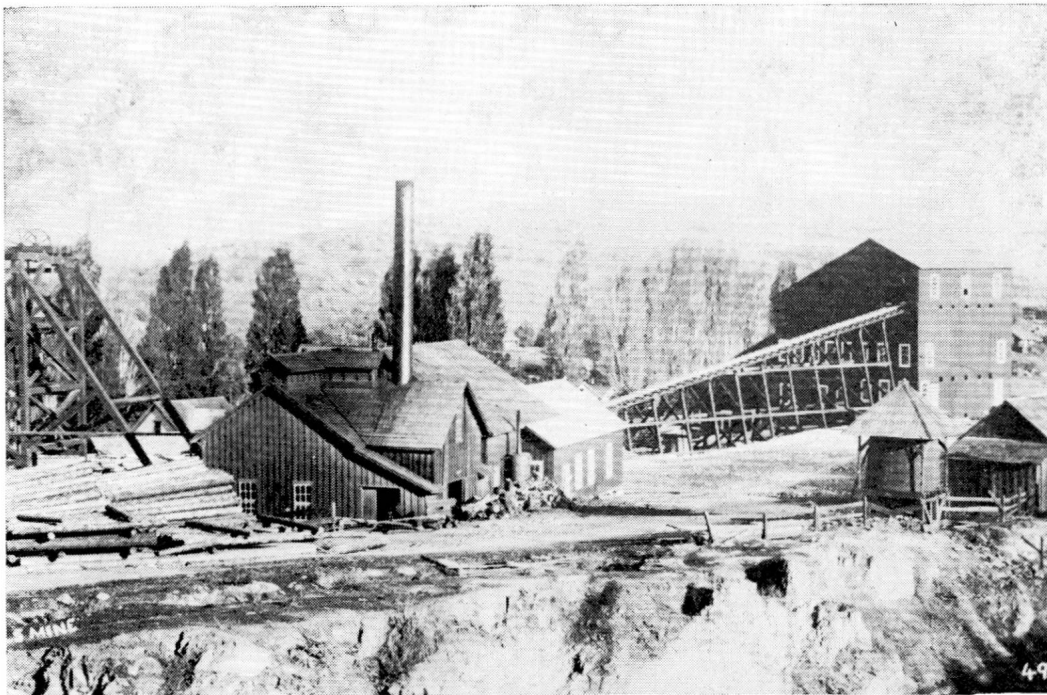
#### LIGHTNER MILL AND SURFACE PLANT

This view, looking west-erly, is just above the present-day Utica Park. The Crystal mine dump is in the background.  
—Angels Boosters Club Collection.



## ANGELS SURFACE PLANT AND MILL

The open cut along the vein is in the foreground. Main Street was once lined by the poplars seen beyond the buildings. One of the shafts is located just in back of the Richfield Service Station.  
—Angels Boosters Club Collection.



stamps being consecutively numbered. This kept the pulp (a mixture of crushed ore and water) agitated and provided for a smooth flow of the mill sands from the battery. The water was fed into the battery to make the pulp as the ore was pulverized by the dropping stamps. A 30-mesh screen at the outlet of the battery allowed the pulp that was fine enough to escape from the battery.

A supply of quicksilver (mercury) was also fed into the battery, the quantity being controlled by the millman's judgment of the amount of free gold in the ore. He would judge this by the build-up of amalgam on the plates (see below). The quicksilver formed an amalgam with much of the gold liberated by the crushing of the ore in the battery. The pulp that flowed through the screen, however, generally had some free gold, in addition to sulphides and sand tailing. This pulp flowed over an apron and onto a series of plates of copper, silverplated and dressed with quicksilver. Most of the remaining free gold was converted to amalgam on the plates, whereas the sulphide minerals and sands passed over.

Periodically, the battery and the plates were "cleaned up" and the amalgam recovered for further treatment. The plates were then redressed and the mill started up again. The gold was separated from the quicksilver in the amalgam by heating in a "retort" to a temperature high enough to drive off the mercury. This was then condensed and used over again. The gold sponge remaining in the retort was melted down, assayed, and then forwarded to the Mint.

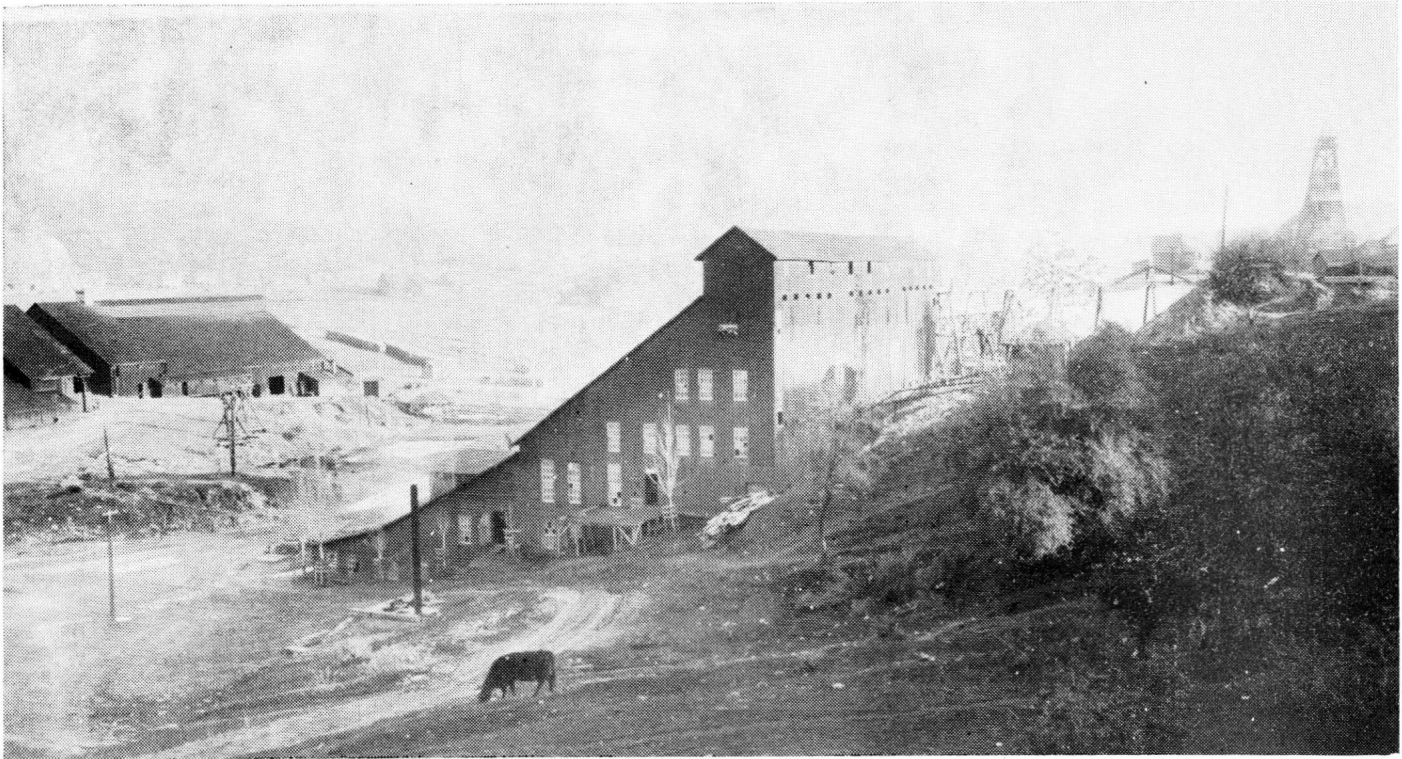
After leaving the silvered plates, the sulphides and sands flowed down to the lower deck to where the vanners were located. These were machines with an endless rubber belt revolving headward against the flow of the pulp. A mechanism built into the vanners caused the belt to vibrate as it moved. This combined movement and vibration separated most of the heavy sulphides and free gold

particles from the sands. The former adhered to the belt, were carried upward and then recovered as the belt returned under the vanner.

After the sulphides were concentrated in the Utica mills they were sent to the Chlorination Works for further treatment. The Lightner had a small chlorinating furnace of its own on Democrat Hill. With the expansion of the Selby Smelter at San Francisco, and the completion of the railroad to Angels Camp in 1902, it soon became economic for all the mills to ship their concentrates direct to Selby.

In the fall of 1891, the Utica Mining Company built a 20-inch tailings pipeline from the Utica mill to a point on Angels Creek opposite the Madison mine. Early in the next year they constructed an 85-by-100-foot building in which they installed a Gates Blanket (or Canvas) plant to treat the Utica tailings in order to recover any remaining gold values. Mr. Cutler was foreman of this plant. In '94, the Stickles mill tailings were also conveyed to the Blanket Plant through a tunnel under Main Street opposite Bird Way.

The Gates machine, similar to a vanner, consisted of a long endless canvas belt which moved counter-current to the flow of the slime tailings (slimes are the finest particles in the tailings). The outer surface of the canvas had a long nap. The heavier particles of free gold and sulphides would sink into the nap and were carried upward to be washed off into tanks underneath the moving belts. The barren slimes would pass over the belt and be washed downstream. Thomas M. Smith, superintendent of the Chlorination Works, reported a recovery for the period from the beginning of the operation until September, 1896, as \$25,315.31. The values in the slime concentrates were recovered in a small cyanide plant constructed at the Chlorination Works in 1893. This plant consisted of one agitator, a vacuum pump, two storage tanks for solution, two zinc filters, one tank for solution, and a filter



STICKLES-UTICA MILL

A view, taken from Deadhorse Hill, looking easterly. In 1903, the old Utica mill was moved from its original site at the present-day Utica Park to the south end of Capt. Nevills' Stickles mill, bringing this plant up to 120 stamps. At this time, the Cross Shaft (upper right) became the main hoisting works for the exten-

sive underground workings of the Utica. One of the Chlorination buildings is on the left, just beyond Angels Creek. This view was taken after the Angels Camp Railroad Station was built, as it can be seen behind the smoke of the Chlorinator.

—Calaveras County Historical Society files.

press for bullion. When the gold came into contact with the cyanide solution, it was dissolved by the cyanide. When the solution reached the saturation point, zinc shavings were added to precipitate the gold.

On Angels Creek, below all the mills, were the Lavignino Arrastras. Here were rerun any of the mill sands that came downstream, for any gold and sulphides missed by the mills.

## The Utica Chlorination Works

The *Mountain Echo* of July 6, 1887, reports that "Mr. P. S. Buckminster is building a chlorination works east of town. Teams have been sent to get the machinery." Some 95,000 bricks were burned in a kiln nearby, and the Melones Consolidated Mining Company contracted to build the plant.

The main building was 100 feet by 44 feet, with a 25-by-44-foot shed on each end. There were two furnaces, one 11 by 80 feet and the other 12 by 80 feet, with a combined capacity of 4½ tons of concentrates every 24 hours. Bowland and Greyson operated the works.

Hayward and Company (the Utica) took over in June, 1888, and Tom Smith became the Superintendent. He continued in this post until his resignation in April, 1899. He was succeeded by F. C. Beedle. In the summer of 1890,

a new brick kiln was built, and bricks were made for three additional furnaces. The five furnaces had a capacity of 22 tons of concentrates a day. By '99, two more furnaces were added, for a total of seven. This was the largest chlorination plant in the state.

Digger pine, cut in four-foot lengths, was commonly used as it was the least expensive fuel available. The local ranchers furnished most of the supply until 1899 when the canal for the powerhouse at Murphys was completed. Then large quantities were flumed down the canal and down a chute to Angels Creek above the powerhouse. The cordwood then was taken by six-horse team and wagons to Angels.

Superintendent Smith was said to have stated that during the best month's operation (January 1895) he poured \$400,000 in gold bullion. He normally retorted the amalgam from all the Utica mills as well as from the Chlorination Works, there. The sulphide concentrate values ran from \$40 to \$60 a ton. Concentrates from outside mills were handled on a custom basis. The gold bullion was taken by wagon to the Wells Fargo agent at Milton, a 22-mile trip.

The chlorination process was introduced by G. F. Decker, of Placer County. The combination of chlorine gas with the sulphide minerals caused a rapid oxidation freeing the gold within the mineral grain. This was called the Plattner process. It consisted of roasting the sulphides

with salt in the reverberatory furnace. The ore was then withdrawn, cooled, and charged into a large circular tank provided with a false bottom. The tank was covered and chlorine gas introduced from below. After 24 to 48 hours the batch was tested as follows: A hole in the cover was opened and a bottle of ammonia held near the hole. If a white cloud of ammonium sulphate formed, the process was completed. The perchloride of gold was washed out with water. This solution was drawn into another vat in which the gold was precipitated by the introduction of iron sulphide in solution. The gold precipitate was then melted and poured into bricks.

The chlorine gas used by the works was manufactured here by using lime, manganese, salt, and sulphuric acid until 1899, when they began to import liquid chlorine from Germany. Each drum would be sufficient for treating 50 to 75 tons of sulphides.

Shortly after the Sierra Railway came to Angels Camp, the chlorinating operation was discontinued and a ten-year contract was made by Utica with the Selby Reduction Works to process the concentrates. An aerial tramway was built to the train depot to take the concentrates directly from the mill. A substantially higher recovery was obtainable from direct smelting than by chlorinating,

which more than paid for the transportation and smelting charges.

## Angels Mill-Men

Some of the better-known mill-men are listed below. Although shown as employees of a certain mill, some of them worked at several of the plants at different times. Those mentioned here were, of course, but a few of the men employed in the mills of Angels.

At the Sultana were George Harper and his brothers. Over at the Angels, William H. Clark was for some years foreman, and working there were D. Layton, E. Marvin, Harry Hogarth, Sr., C. Cottrell, H. Dorrah, and Clarke. Down at the Lightner, where G. H. Fox was foreman, was Jack Maud. John Reeves was the man that co-ordinated the Utica Mills. One of his right-hand men was William Keyes. Reeves brought in William J. Loring as his assistant, and on Reeves' death in the late 90's, Loring took over as mill superintendent. Frank Gorman worked at the Stickers and Fred Beers at the Gold Cliff mill. Some others working in the Angels mills were Joe Butler, Jack Matrovich, Ralph Lemue, Frank and Len Williams.



**THE CHLORINATION WORKS**

Looking easterly at the Chlorination Works. The Helioport is now located on this site. Highway Four cuts across the southeast end of the old foundations. This

view was probably taken about 1900, several years before the big Chlorinator shut down.

—Calaveras County Historical Society files.

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The Calaveras County Historical Society, a non-profit corporation, meets on the fourth Thursday of each month at the Grange Hall in San Andreas—except for dinner meetings which are held each quarter at different places in the county.

## Editorial

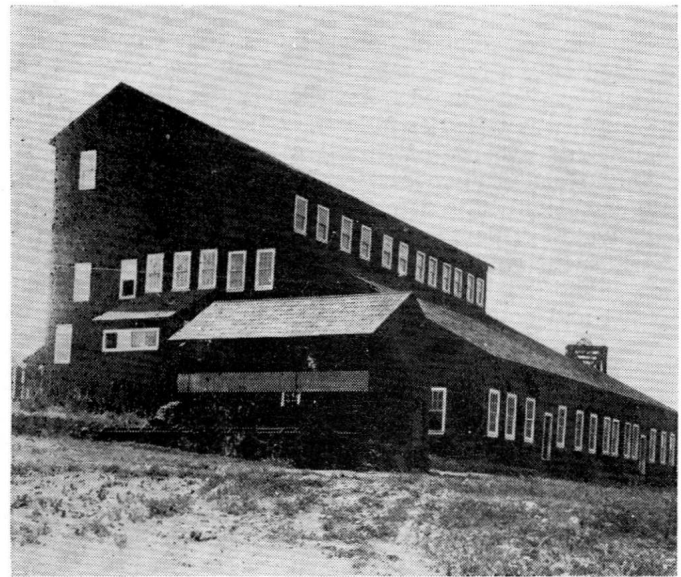
Another carefully researched article by Ed Leonard, "The Mills of Angels," brings back to life the once busy gold-quartz milling plants of this town. The article is particularly timely because of the almost total and complete disappearance of these mills of Angels Camp. Although many more men worked in the extensive underground workings deep below the town's streets than did on top, it was the intense milling activity that was so well known to resident and visitor alike.

## Forthcoming Meetings

- January 28th—Pot Luck Dinner at San Andreas. Historical essay winners will read their prize-winning essays.
- February 25th—Grange Hall at San Andreas. Second meeting on Calaveras Doctors. There will be papers on Doctors Holland, March, Herrschner, Stukey, Freeman and Wyrick.
- March 25th—Grange Hall, San Andreas. Conclusion of reports on Calaveras Doctors, and hospitals in the County.

## New Members

Mr. Rodger D. Carlson, Pomona  
Mr. George V. Due, Escalon  
Mrs. Rose Marie Faulkner, Castro Valley  
Mrs. Myrtle Gallinger, Auburn  
Mr. and Mrs. Fred Goodell, Greenbrae  
Mrs. Walter Hansen, Redding  
Mr. Charles H. Rohrbacher, Foster City  
Mrs. Warren Tufts, Bremerton, Washington



THE ANGELS MILL

This is the view a passerby caught of the Angels mill, as he drove or rode up Main Street toward Altaville. Forty stamps and 16 Frue vanners were housed in this building.

—Courtesy of the Stuart Library, Univ. of the Pacific.

## In Memoriam

Rose Marie Blackwell      Maude Poyner  
Irene Corneau              Jeanette Solinsky  
Muriel Genochio            Grace Tiscornia  
Miriam Petithomme        Agnes Tower  
Gwen Wyllie

## Agostini Building Restoration

We regret to state that, as we go to press, we still have not completed arrangements with Black Bart Inn for deeding the Agostini Building over to the Society. The "hang-up" involves the tax status of the transaction relative to Black Bart Inn. We are hopeful that the matter can be concluded in the near future and restoration work begun.

## Professor Wood on TV

We have been enjoying Coke Wood's telecourse on Californian history on Channel 13, KOVR. For those of you who have not yet tuned in, Dr. Wood is on every Wednesday and Friday at 6 a. m. The second semester starts on February 3rd! You may enroll for two units of college credit by applying to San Joaquin Delta College, 3301 Kensington Way, Stockton, California 95204.

## Mills of Angels References

References used in this study included MINING AND SCIENTIFIC PRESS, various publications of the California Division of Mines, contemporary newspaper accounts, and personal reminiscences of old timers.