Alfred A. Hart, Artist

Alfred A. Hart: Central Pacific Trestle at Newcastle, 1865

A rare example of Hart producing a single lens image of the Central Pacific Railroad, probably using his stereo camera modified for panoramic work as shown on the first frontispiece. The first car in this view is an inspection/excursion type and the second is an early passenger car borrowed from the recently-purchased Sacramento Valley Railroad. This mounted print, published by Whitney and Paradise from a Hart negative was probably taken in mid-1865. See also Appendix A, No.145 for a view of this same trestle under construction. Highway 80 now passes under the center of its modern steel replacement.

The Railroad Photographs

of

Alfred A. Hart, Artist

BY **MEAD B. KIBBEY**

Edited by Peter E. Palmquist

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Barry Swackhamer permitted the photographing of many of his rare Hart stereographs appearing in Appendix A, and later proofread parts of the text and provided many of the correct railroad terms needed.

DEDICATION

To my wife, Nancy, for her untiring assistance in checking wording and grammar, for the long hours spent at her computer, for providing help on innumerable photographic excursions, and the inspiration to continue when the whole effort just seemed too difficult.

To Alfred A. Hart who, although he died fourteen years before I was born, I think of as my respected friend.

(Fig. 1.) Alfred A. Hart (1816-1908). While not the first to take pictures in the state, he was born years before the other great early California photographers. Born in Norwich, Connecticut and died in Alameda California. (Photo from private collection.)

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(Fig. 2) Central Pacific track workers on the Utah desert. From a stereograph published by E. & H. T. Anthony & Co., New York.

EDITOR'S FOREWORD

Mead Kibbey has been fascinated with the photographs of Alfred A. Hart for at least two decades. He has seldom, if ever, passed up an opportunity to champion Hart as an artist whose life and work should be better known today. Happily for us, this obsession has culminated in this remarkable, and highly personalized tribute to the man who documented the construction of the Central Pacific Railroad during the years 1864-1869.

Although *The Railroad Photographs of Alfred A. Hart, Artist* contains a great deal about railroading, this is far from a typical "train" book. Instead the author has chosen to focus on the events and circumstances of railroading that are

often over-looked or only briefly discussed. Among these are the vicissitudes of tunneling--with both nitroglycerin and black-powder techniques--in the brutally dense granite of the rugged California mountains. He has also addressed the question of how the workers were able to keep tunnels on a perfectly straight course while working from both sides of a mountain. Moreover, *The Railroad Photographs of Alfred A. Hart, Artist* is not just a "photographer's monograph." Rather it stands as an excellent primer on the general practices and problems attendant to wet-plate photography. Especially interesting is Mead's discourse on the ins-and-outs of commercial stereography in the American West during the 1860s.

To study Hart's photography has been to concentrate on the numerous minute details to be gleaned from a wide variety of diverse and scattered evidence. Mead, for example, has successfully collected nearly every known photograph ever taken by Hart of the Central Pacific Railroad. Moreover, he has made a special point to visit most of the sites photographed by Hart, and has placed his own tripod in the precise same spot as Hart's, some one
hundred thirty years later. (Many of these locations were amazingly difficult to reach today and must have been far harder during the time of wet-collodion photography.)
In order to more fully understand Hart's stereography, Mead experimented with, and produced, actual stereoscopic negatives with a camera dating from Hart's own era. Through such personal investigation, he has come to intimately understand the "how-to" of different focal length lenses in field photography. He quickly discovered just how hard it is to adjust an 1860s-style tripod to the rough mountain terrain and jumbles of broken granite that were still present from the original CPRR blasting. Mead has meticulously traced each step of commercial stereograph production, ranging from optical spacing of the prints to labelling the finished card, Driven by his near-obsessive need to understand the process Mead even manufactured his own salted paper.

Mead has been particularly conscientious in his attempt to date each photograph, to provide insight into why they were taken, and wherever possible to place *himself* "on the scene." (Compare, for example, Fig. 39 showing Hart's shadow taken in the 1860s and Fig. 78 of the author's shadow taken in September 1994.)
Bottom line? History, biography, great photographs, and seven super appendices (including a *catalogue raisonne* of every known Hart CPRR stereograph).... Anyone who has ever wondered about the exact origins of the 364 stereographs which Alfred A. Hart took to document the construction of the Central Pacific Railroad will find this book an indispensable reference.

P. E. P.
Arcata, California, June 10, 1995

AUTHOR'S PREFACE

In 1962, to illustrate a talk on the centennial of the start of the Pacific Railroad at Sacramento, I obtained a set of old glass lantern slides from a friend at the Southern Pacific Railroad. My talk received a modest reception, but members of the audience kept coming up to the podium with the identical question, "Where did you get those incredible pictures?." Clearly the photographer had reached across nearly a century with a powerful proof of the old adage "A picture is worth a thousand words," at least my words.

It was not until thirteen years later, while beginning to collect nineteenth-century photographs, that I gradually realized those great pictures, and many more, had been taken by Alfred A. Hart (1816-1908) of Sacramento, during the construction of the Central Pacific Railroad from 1864 to 1869. I eventually learned that he had published 364 numbered titles of the entire project (plus many variations), that these images had been copied and republished for years, that they had sometimes been claimed by other photographers as their own works, and that since 1870 no single collection has held all 364 of his titles. Although some fine articles about Hart had appeared in magazines, I could not find a single book about him or his work.

Locating the exact sites from which Hart took many of his views in California was just difficult enough to make it fun, and it became a sort of hobby with me. In the process I came to deeply respect Hart, and to feel that although a century apart, he and I had photographed a work of giants. For nearly a century, the Sierra Nevada Mountains had been considered an impenetrable barrier by the Spanish settlers of California, and the Native Americans only ventured into those forbidding heights during the

few summer months. In the winter wind-gusts at the summit reach 100 miles per hour and the annual snowfall can exceed fifty *feet*. Starting in the 1850s, the lands of Northern California have been carefully surveyed into townships and sections by a succession of government agencies. The earliest surveys started with the most valuable and accessable areas; yet so remote were the Sierra summits that even in 1995, entire townships of 36 square miles are still waiting to be surveyed into sections. Clearly, those who drove the Central Pacific through the Sierra, as Herodotus said of the builders of the pyramids "seem a mightier race of men than now inhabit the earth."

As the official photographer of the Central Pacific, Hart was the only one to record scenes during the actual construction of the

After the completion of the road to Promontory, Utah, Hart was followed by several famous contemporaries, such as Eadweard J. Muybridge (1830-1904), John James Reilly (1838-1894), and Charles R. Savage (1832-1909).[1]

A few local photographers operating from such places as Dutch Flat, Truckee, and Auburn also produced views of the railroad. Each of these photographers published in Hart's stereo-card format, and a surprising number of their images were taken from exactly the same camera locations previously selected by Hart.

Although they are very difficult to locate today, Hart did produce a few photographs in other formats such as the carte de visite and 5-by-8 inch formats, plus many half stereos (a single image) which were used for albums and catalogs. For reasons to be further explained in the text, these half stereos are somewhat larger in area than those printed for the standard-size stereographs and include additional scenery which better displays Hart's keen eye for composition.

1. Others were Charles Bierstadt (1819-1903), C.L. Pond, Thomas C. Roche (1827-1895), and Carleton E. Watkins (1829-1916). Watkins did not retake Hart's California railroad scenes exactly, but later photographed many sites along the CPRR for his "New" series. Stereo publishers using images of the railroad purchased from Hart and other photographers included: Thomas Houseworth (San Francisco), Bradley & Rulofson (San Francisco), E.& H.T. Anthony Company (New York), and John Soulé (Boston).

railroad over the mountains. He was permitted to stop trains and work crews for the time needed to set up his camera and to find the best location for his photographs. He was also allowed to have his small photo-darkroom-wagon hauled to the end-of-track on a railroad flat car where he pushed ahead to capture scenes of the early stages of excavation for the road bed. Because he was on site well before the completion of the famous snowsheds in 1869, and before the tracks were in such heavy use, Hart was able to take advantage of photographic opportunities not available to other photographers of that era. In addition, his photographs taken along this route during the actual process of building trestles, constructing enormous embankments, and digging tunnels can *never* be duplicated.

In order to learn more of the operating details of Hart's photographic equipment, I recently obtained the use of a 5-by-8 inch wet-plate stereo camera and an 1860s-tripod. The absence of a shutter on the camera, as well as the difficulty of loading and unloading negatives in the field were not unexpected problems, but the tripod proved to be an unpleasant surprise. In using tripods for 60 years, I had never seen one having a head with no provision for turning or tipping the camera, no adjustment for height except by spreading the legs of the tripod, and legs of fixed length. The tripod only weighed four and a half pounds, but it proved quite difficult for camera aiming and composition.

In re-photographing some of Hart's scenes, particularly in the Bloomer Cut and at Cape Horn, I didn't even attempt to use the old camera. Even with a light modern 6-by-7 cm. format

camera, I found myself shooting with one arm wrapped around a small tree and hoping my rubber-soled shoes wouldn't slip on the rocks scattered by construction blasts over a century ago. There proved to be recurring problems in finding the precise locations where Hart had placed his camera, and then surprising difficulty in retaking the photograph. In the easy places, where the location still had the same name and a paved road was nearby, the problem was nearly always one of intervening trees. In Hart's day, photographers in
the mountains could move around easily because the big trees had already been cut down for lumber and ties, and the smaller ones provided firewood for the locomotives and the steam engines which powered the local mines and sawmills. (In an 1854 report, Lt. George B. McClellan estimated that on heavy grades a locomotive burned about 8 cubic feet of firewood *per mile*, or a cord every 16 miles.) Trees grow rapidly on the western slopes of the Sierra Nevada, and during the intervening century they appear to have had a particular affinity for the areas directly in front of Hart's best camera locations.
Some of his finest photographs were taken from the tops of boxcars or locomotives and because of this,
I carried a six-foot folding ladder on my truck, and by setting it up between the rails and standing on the top rung, I could get my camera at almost the same elevation Hart used. Unfortunately when I was on top of that trembling ladder (the ties were spaced so that only two of the ladder's four legs were resting on a tie), the sound of an approaching train greatly reduced my interest in perfectly duplicating Hart's composition. By using modern topographic maps, many isolated locations were quite apparent, but often proved to be more than a mile from even a four-wheel-drive road. In those instances several hours were needed to hike in and back out with my camera, a light tripod, the rolled map, 8-by-10 inch enlarged copies of the appropriate Hart prints, and a compass to measure the direction of the shadows in his photographs (to help establish the time of day when he had taken the original views).
After spending more than ten years looking at Alfred A. Hart's fascinating photographs and visiting over 50 of the sites where he placed his camera along the Central Pacific, I can say that it is quite disappointing that Hart is not better known today. When seen in a stereoscopic viewer, his magnified stereographs fill one's visual space with an exciting reproduction of the scene itself. An almost uncanny feeling of time-travel occurs when one views a Hart stereograph of a bustling railroad settlement as it appeared 130 years ago and compares it to the now-deserted location.
Despite the unique clarity of spatial relationships in stereographs, it appears exceedingly difficult to excite today's art historians with 3-by-3 inch images, even when the results are quite beautiful. Beaumont Newhall, writing in the 1974 edition of the *Encyclopedia Britannica*, perhaps best sums up this perceptual problem with the words: "The aesthetics of two-dimensional picture making cannot be applied to these views. Indeed, many art critics hold that stereography is so rooted in illusion that such pictures can never be of lasting value." This is especially ironic when one considers that Hart's most famous contemporary, Carleton E. Watkins, whose mammoth prints have had almost endless reviews, thought enough of Hart's work to give it the ultimate compliment -- he later claimed it as his own.
Hart was the first person to photograph an entire construction project of this magnitude, a total of 742 miles from Sacramento to Omaha, and completed in six years and five months. For comparison, the Great Wall of China was constructed intermittently from 300 BC to 1500 AD and was 4,000 miles long with all its branches. If built at the same average rate as the

CPRR, the Great Wall would have been completed in 38 years, that is to say, before 262 B.C. Conversely, if the Central Pacific had been built at the same rate as the Great Wall of China, the rails would just have reached Reno in 1932 in time to celebrate Franklin Roosevelt's first presidential election.

In photographing the building of the Central Pacific, Alfred A. Hart did perhaps as good a job as has ever been done. In the 1970s, Jimmy Durante had a television show which always ended as he moved across a darkened stage pausing momentarily in a series of small spot-lighted circles. Hart's views similarly give us ten-second circles of recall across the darkened stage of the history of the building of the Pacific Railroad.

In business matters, Hart seemed to be moderately successful and wrote good advertising copy for his various ventures. Because of the absence of available information

on his efforts to market the stereographs he published, it can be assumed his main sources of sales were in wholesale lots to the Central Pacific and through his store in Cleveland. Despite the longer period over which Hart took California photographs, the publishing efforts where he was identified as the photographer were apparently limited to the years 1865 through 1870. This short period and the relatively few such stereographs available today, may explain why photographic historians have tended to ignore him.

The conditions overcome by the railroad builders as they pushed the road to an altitude of 7,000 feet in less than 90 miles were simply appalling. Their almost religious fervor carried them through rain, mud, snow, and terrible winds around thousand foot cliffs, across deep canyons, and through literally miles of solid granite. The thundering might of their assault on the Sierra, must have inspired Hart to continue his photography despite the difficulties and danger involved. His glass plates were heavy and fragile, his negatives had to be exposed while wet, sensitized and developed in a tiny dark tent in the presence of noxious fumes, and his chemicals were corrosive and poisonous. His minimum exposure was three to five seconds, and dozens of workmen and horses had to be induced to stand still for a single scene. The negative was developed on the spot, and if unacceptable, the whole process had to be repeated. Some of his finest views were taken from the roofs of locomotive cabs, from narrow ledges over the mouths of tunnels, or from rocky slopes over cliffs. Like the men he photographed, nothing seemed to stop him.

Because of their great clarity, unique subject matter, and lack of copyright protection, Hart's images were subsequently copied and recopied as woodcuts, engravings, and copy-photographs; seldom if ever with attribution to him. For example, as recently as 1989, the Golden Spike National Historic Site Museum was still incorrectly identifying an enlargement of Hart's No. 358, "The Monarch from the West" as having been taken by Andrew J. Russell.[2] As a result of these innumerable reproductions, the wide distribution of Hart's work provides future historians with hundreds of caches of information about the Central Pacific construction.

Based on the titles Hart used, one can observe that he never belittled the people depicted, as Muybridge and many others sometimes did, never complained about the conditions under which he worked, and consistently displayed respect and admiration for the accomplishments
of the builders of the railroad. As an artist rather than an engineer, Hart did not record some details that would be fascinating now, such as the interior of a workers' dining room,

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2. see illustration in Peter Palmquist, *Photography in the West-2* (Manhattan, Kansas: Sunflower University Press, 1989) p. 120.

the actual placement and subsequent detonation of a nitroglycerin or black powder charge, the setting up and use of a "portable" locomotive turntable, and close-in views of trestle and cliff workers. In these omissions he may well have been deterred by the railroad management, or by his own ideas of public interest.

Although we may never fully understand Hart's personality, he leaves the impression of a cheerful, kindly, innovative, and incredibly energetic person of whom his temporarily adopted city of Sacramento may be very proud.

M.B.K.
Sacramento, May 10, 1995

INTRODUCTION

AND

A Brief History of the Construction of the Central Pacific Railroad

On April 28, 1869 the Central Pacific Railroad Company (CPRR) paid eight Irish track layers four times their usual pay of a dollar for one day's work.[3] In eleven back-breaking hours on the desert at the north shore of the Great Salt Lake, they had set an amazing and strangely American world record.

The rails used by the CPRR were ten yards long and weighed 56 pounds per yard, or 560 pounds for the rail. After the ties were laid a small handcar brought up rails to the end of the track, and four track layers (using track tongs) picked up a rail from the left side of this car and quick-stepped forward 30 feet to carefully lay the rail in place, ready for spiking down to the ties. At the same time the other four completed the same operation with a rail from the right side of the car. Each track layer on that day lifted his 140 pound share 1,762 times. By noon they had laid six miles of rail and were offered the chance to quit while a substitute gang took over. Those iron men refused the offer and laid four more miles in the afternoon.

When the whistle blew at seven that evening they had lifted 1,973,440 pounds of steel, not counting their heavy track tongs, and had advanced the CPRR ten miles and fifty six feet in a single day. Two days later, construction was completed and the CPRR had won its race with the Union Pacific Railroad Company (UPRR) to reach their junction point at Promontory, Utah. For 690 miles and 2,304 days, thousands of men had worked together to build the railroad eastward from Sacramento, yet only one woman and one photographer had repeatedly traveled the entire route. The woman was the wife of the construction superintendent, James Strobridge, and the photographer was Alfred A. Hart of Sacramento.

This is a story about Hart's stereo photographs, especially the remarkable set of 364 published images he took between 1864 and 1869 to document the building of the CPRR. The construction scenes are unique because they depict the last great project in the United States built almost entirely by manpower. The excavation "technology" was limited to black powder and a thousand or fewer horses. (The newly patented nitroglycerin was used for only 900 feet of the 690 miles.)

3. Their names were Tom Daley, George Elliot, Patrick Joice, Edward Kelleen, Mike Kenedy, Fred McNamare, Mike Shaw, and Mike Sullivan---George Kraus, *High Road to Promontory,* (Palo Alto, Calif.: American West Publishing Co., 1969) Footnote Page 248 and Photo 251.

Because of the enormous distance from the industrial East, and the pressing needs of the Civil War, millions of cubic yards of earth and stone were moved by methods common in the eighteenth century. Even the 75,000 tons of steel rails were lifted across the docks at Sacramento by hand powered cranes.
Hart's photographs clearly documented the incredible tasks accomplished, without being heavy handed. His stereographs of local Indians, for example, picture them as a dignified people and he carefully recorded the names of the tribes to which they belonged. Such scenes are also subtle indicators of the remarkable accomplishments in race relations made by CPRR superintendent, Charles Crocker.
To the east, the UPRR workers had been in constant conflict with the Native Americans encountered, and even required the protection of U.S. Army troops. Charles Crocker not only refused the proffered services of Army protection, but personally arranged a treaty with the tribes along the CPRR between California and Ogden, and later with the Apaches along the Southern Pacific. In 1888, the CPRR could proudly state that the treaty:

...has on each side been most faithfully maintained from that day to this. Many times since the construction of the road these tribes have been at war with the United States. In no single instance have they ever violated that solemn treaty or injured a man connected with the railroad or a passenger borne upon its trains...In striking contrast to the faith kept by the Piutes and Apaches stands the broken faith of a civilized nation with this company.[4]

(The "broken faith" referred to changes attempted by the U. S. Government in the original Railroad Act.)

The story of the building of the Central Pacific Railroad has been repeatedly told in a number of well- researched books and articles. As a result, this account will only touch briefly on a few of the historic details and will include bits of information derived from *previously unused* original sources. It should also be understood that a unique set of incentives regarding the grand plan of a transcontinental railroad existed well before Alfred Hart

began taking his stereographs[5] of the building of the Central Pacific Railroad. Nationally, the recognition of the need of a Pacific railroad actually predated the 1848 purchase of California by the United States. An early example began in 1841, when at his own expense, Asa Whitney of New York researched and later promoted a detailed plan for financing a railroad to the Pacific.[6] Beautifully simple, the plan proposed that the United States sell him 80 million acres, in a strip 60 miles wide from Lake Michigan to the Pacific Ocean, for 10 cents an acre. He would then build a railroad along the center of this property, paying construction costs by selling some of the land as he progressed.
When the tracks reached the Pacific Coast he would donate the completed railroad to the United States Government and retire on the modest profits available as he sold off the remainder of the 80 million acres. Remarkably, the legislatures of over 20 States approved the plan, but it failed in Congress because of Southern opposition. Mr. Whitney died, broke, on a milk route in Washington, D.C.
San Francisco's first newspaper, *The California Star*, on April 10, 1847, had noted the talk of a Pacific Railroad. In a surprising prediction of the need for the Dutch Flat Wagon Road,

4. Creed Haymond, CPRR general solicitor, *Oral Argument* before the select committee of the U. S. Senate, March 17, 1888.

5. "Stereograph" as used here, refers to pairs of nearly, but never exactly, identical photographs about 3 inches square mounted on a card 7 inches long and 3 to 4 inches wide. When viewed through two wedge-shaped lenses these stereographs fill the observer's field of vision with a three dimensional image of the original scene. Here and in the literature about stereographs of the 1860s, the words "Card," "Stereo Card," "Stereographic View," "Stereoscopic View," "Stereo"(used alone), and "View" have roughly the same meaning and refer to the finished product of the stereo photographer, that is, two images glued to a card or mount ready to be seen in a viewer or "Stereoscope."

Transparent stereo views mounted on glass came in several sizes, and were frequently referred to as "Glass Stereos." "Image" as applied to stereos meant a single print or negative, not the required pair together. "Scene" generally referred to the actual object or area depicted photographically, but occasionally meant single, non stereo prints of larger size. The word "stereograph" entered the International Scientific Vocabulary in 1861, but was not used by Hart or his American contemporaries in advertisements.

6. 31st Congress, 1st Session, March 13, 1850, *Whitney's Railroad to the Pacific* (Printed for the House of Representatives, Washington D.C. 1850) Report 140 to accompany HR 156.

which in 1864 was built to parallel and precede the Central Pacific, the editor strongly favored building a road for wheeled vehicles before a railroad was attempted.
In his State of the Nation address in 1849, President Zachary Taylor predicted the rapid growth of large cities in California and the necessity of a railroad within the United States to reach them. [7] (A charter already existed for an inter-ocean railroad across Panama.) At this time (1849), Alfred A. Hart was listed as a portrait painter at 7 Pearl Street, Hartford, Connecticut.[8]

Congress also recognized the national importance of a Pacific Railroad. In March, 1853 it directed the War Department to review Lt. Beckwith's 1849 survey and complete surveys of four new possible routes from the Mississippi River to the Pacific Ocean. These enormous projects were carried out with such speed that on February 27, 1855 the printed report was submitted to Congress by the Secretary of War, and future president of the Confederacy, Jefferson Davis. The title page of the first volume tells the story and reads:

Reports of Explorations and Surveys to Ascertain the most practicable and economical route for a Railroad from the Mississippi River to the Pacific Ocean. Made under the direction of the Secretary of War, in 1853-4, according to acts of Congress of March 3, 1853, May 31, 1854 and August 5, 1854.--Volume I.

This single volume contains 641 pages 8-1/2 by 11-1/4 inches. The report was continued through Volume XIII and totalled about 7 thousand pages. It was not just a railroad report, but also described in detail vast areas of the Trans-Mississippi West. For example, the naturalists attached to the survey parties made beautiful engravings of birds, snakes, fish, sea-shells, minerals, and trees, all of which are included. Some of the engraved maps fold out to sizes as large as 36 inches by 40 inches.[9]

In 1857, a Sacramento resident and Chief Engineer of the newly completed railroad to Folsom, Theodore Judah, had prepared a pamphlet titled "A Practical Plan for Building the Pacific Railroad" which he sent to every member of Congress.[10]
Meanwhile (in 1857) Alfred Hart was still in Hartford, Connecticut, and had become a partner of daguerreotypist, Henry H. Bartlett.
Californians in particular agreed that the railroad would change their history forever--Robert Draper, for example, in his *Sacramento City Directory for 1`866*, predicted that it would "prove an incalculable blessing to the whole nation"[11]

STARTING THE RAILROAD

The Central Pacific Railroad Company (CPRR) was incorporated in Sacramento on June 28, 1861, with Leland Stanford as president, Collis Huntington, vice president, Mark Hopkins, secretary-treasurer, E. B. Crocker, company attorney, Charles Crocker (E. B.'s brother), a director, and Theodore Judah, chief engineer.[12]
In October, Judah was sent to Washington to induce Congress to assist in financing construction by providing appropriations of land and guaranteeing the interest payments of the CPRR-issued bonds of the railroad.
As possibly the most successful lobbyist of all time, Judah saw

7. House of Representatives, Ex.Doc. No.5, *Message from The President of the United States to the Two Houses of Congress at the Commencement of the First Session of the Thirty-First Congress-- read December 27, 1849* (printed at Washington for the House of Representatives, 1849), page 12, paragraph 5.

8. *New England Mercantile Union, Business Directory, 1849* (New York: Pratt & Co., 1849), page 307.

9. Despite the incredible effort made in surveying and reporting on the various routes, no description is given of the route later taken by the CPRR down the Truckee River through a pass cut by the river in the eastern summits of the Sierra Nevada. (The Donner party came *up* this way as had hundreds of other immigrants.) The route is hinted at when the report mentions a brief communication from Lt. Col. Steptoe in Utah at the bottom of page 16 of the Volume I described in the text.

10. Wesley S. Griswold, *A Work of Giants* (New York: McGraw-Hill, 1962), page 9.

11. Robert E. Draper, *Sacramento City Directory for 1866,* (Sacramento: H. S. Crocker, 1866), page 33 under "Railroads."

12. Leland Stanford was also the Governor of California 1862-1864.

the Pacific Railroad Act signed into law by President Abraham Lincoln on July 1st, 1862. In addition, 17 senators, 44 representatives and the Secretary of the Senate wrote to Judah: "We cannot let this opportunity pass without tendering to you our warmest thanks for your valuable assistance in aiding the passage of the Pacific Railroad Bill through Congress."[13]

After lengthy negotiations, the bill enacted provided that the United States would receive a mortgage on all the assets of the two corporations building the Pacific Railroad (the CPRR in the West and the Union Pacific Railroad (UPRR) in the East). In return the two corporations would be granted a strip of land 200 feet wide on both sides of the right-of-way and 6,400 acres (10 square miles) for each mile of railroad completed. This land had been available for years to the public at $2.50 per acre and was thus reckoned as being worth $16,000 per mile, but most of it was worth far less and remained unsold by the railroads for over a century. Most importantly at the time, the railroads would also receive a *loan* (not an outright subsidy) in the form of $16,000 in 30-year six percent government bonds for each mile constructed. Because of construction difficulty in the high desert between the Rockies and the Sierra Nevada, this rate was doubled to $32,000 per mile and in the Rockies and the Sierra Nevada it was set at $48,000 per mile. The interest and principal were to be repaid by the railroads.

No bonds or land was to be given either railroad until it had completed 40 miles of track, and payment for transportation and other services by the railroad to the government were to be credited to interest and principal on the bonds until all had been paid in full. Possibly because of this provision, the CPRR repaid all the interest and principal before it was due. As a final "incentive" the bill required that if the railroad were not completed by July 4, 1876 it would be entirely forfeited to the government. The legislators seemed assured that the railroad bill would do more for the country than the builders of the Pacific Railroad.[14] From subsequent letters and recorded conversations, it is evident that the management of the CPRR also felt the bill was short on carrots and long on sticks, but the best they could get under the circumstances.

The Railroad Act, by not setting a junction point for the Central Pacific (coming from Sacramento) and the Union Pacific (from Omaha) made the project a race between the two railroads, with only the completion date, "before July 4, 1876," an established requirement. The intelligence of Congress in this matter was later demonstrated by the fact that the railroads were completed over seven years before the required date.

Before returning to California, Judah had purchased cars, locomotives, and enough track hardware to build 50 miles of rail. Huntington remained in the East to sell CPRR bonds, pay for the equipment, and arrange shipping, which would have to pass Confederate raiders on the trip south to pass around Cape Horn.

The CPRR builders were under enormous economic pressure to construct as rapidly as humanly possible--both for loan guarantees and land grants during construction, and then a greater share of all future freight revenues involving the CPRR and other carriers. Never before or since has such a huge project been built where its starting point (Sacramento) was so far from its suppliers (New England). From Boston by sailing ship around Cape Horn it was over 16,000 miles to Sacramento. As a comparison--when they reached the far end of the Trans-Siberian Railroad in Vladivostok, the Russian builders were "only" 4,750 miles from Moscow. The long sea voyage for CPRR supplies ended at the railroad docks at the foot of I, J and K Streets in Sacramento. (Fig. 3)

Regardless of the distance factor, the incredible difficulties of building a railroad over the Sierra were widely recognized--an example being the prospect of boring through solid granite at

13. *Report of the Chief Engineer of the Central Pacifc Railroad Company of California, on his Operations in the Atlantic States.* Cited by Griswold page 19.

14. George Kraus, *High Road to Promontory,* p.42.

the summit, one of the longest and at the time, the highest tunnel in the world. [15] (See Fig. 9)
Captain (later General) William Tecumseh Sherman, an experienced Army engineer and surveyor who had spent years in California, wrote to his brother of this project: "If it is ever built, it will be the work of giants." [16] Using the flowery language of a nineteenth-century orator, and 20 years after the fact, Creed Haymond described the conditions actually overcome:

From Newcastle to Emigrant Gap [a distance of 53 miles] the work was about as heavy as the average of the work on the Pennsylvania Road across the Allegheny Mountains. From Emigrant Gap to Truckee the difficulties encountered can never be described so as to be appreciated by one not conversant with that range of mountains or who has not lived among them during the months of almost constant storm. On the Western slope the [annual] snow-fall will vary from 30 to 60 feet in depth and snow has remained upon the summit to the depth of four feet as late as July. [17]

The CPRR directors were experienced merchants, but prior to the start of construction on January 8, 1863, only Theodore Judah, the chief engineer, had done any railroad building.

(Fig. 3) Alfred Hart: CPRR dock at foot of "I" Street, Sacramento from the deck of the steamer *Capitol*, looking northeast.

At left center hay scows, often seen on the Petaluma River, have been altered to carry long timbers for railroad bridges. Three hand powered cranes (painted white) are located along the edge of the dock, and a man proudly stands on a pile of 12 x 12 timbers with his hand on the closest crane. Nearby are 20 or 30 kegs of track spikes and the shiny object to their right is the stack of a locomotive.
This image is enlarged from a portion of an untitled Hart stereograph probably taken in the winter of 1867/1868.

15. The "Summit Tunnel" (No.6) is 1,659 feet long, 16 feet wide and about 20 feet high. It was cut through solid granite from four faces using a central shaft 73 feet deep to permit cutting both ways from the middle. Holes for the nitroglycerin were drilled entirely by hand. It took 1,051 working days of 24 hours to complete the tunnel. Because of the name, newspapers reported that the highest point of the railroad was in the tunnel. It was actually 400 feet outside the west portal, and in the tunnel, the line slopes down steadily to the east, the track being 30 feet lower at the east end. "The Summit Tunnels" referred to tunnels 6 through 13 spaced out over 7 miles with lengths totalling 4,648 feet.

16. Wesley Griswold, *A Work of Giants,* p. 15.

17. Creed Haymond, General Solicitor of the Central Pacific in *Oral Argument* before the Select Committee of the U.S. Senate on March 17th and 26th and April 7th 1888 (p. 137). Incidentally, Haymond had been an attorney in La Porte, California in 1863 and probably knew Alfred A. Hart who was working there in that year.

(Fig. 4) July 1990, Inside wooden snowshed at Norden just after a locomotive passed. Huge roof and wall timbers were required at this 7,000 foot elevation about one mile west of the Donner Summit Tunnel. It is not unusual for snow depths here to reach 18 feet. (MBK photo)

Judah previously had designed a rather difficult section of track in New England and had been chief engineer for the first passenger railroad in the West, the 22-mile Sacramento Valley Railroad (SVRR) to Folsom from Sacramento, completed in 1856.

In laying out the route of the Central Pacific, Judah examined many alternative routes. In the period ending October 1, 1861, he reported making barometrical surveys (using a barometer as an altimeter to obtain elevations) of 765 miles, and preliminary and location surveys of 580 miles for a grand total of 1,365 miles. The route finally built was quite close to the one he laid out, but in regard to Sierra snows he sadly underestimated both their power and intensity. When Judah reviewed his research, he concluded that two snow plows, working east and west from the summit, could always keep the track clear.[18]

In a strong display of faith in the ultimate victory of the Union forces in the Civil War then raging, the formal construction of the CPRR was commenced at Front and K Streets in Sacramento on January 8, 1863. The UPRR did not lay their first rail until July 10, 1865 when the war was over and the CPRR already had over 50 miles of track in place.

On the CPRR, the first shovel full of earth was turned by Leland Stanford who was both the president of the railroad and governor of California. From that day forward the building of the CPRR never stopped, although shortages of capital occasionally slowed its progress.

Judah earlier had designed a large timber bridge crossing the American River at Folsom as part of an extension of the SVRR to Auburn. In this bridge, called a *deck* bridge,[19] the tracks were supported on the top of the structure just as Judah specified on the last bridge he designed for the Central Pacific at Dry Creek near Junction (now Roseville). In his last formal report to the Directors, dated July 1, 1863, Judah described the details of the Dry Creek Bridge as well as those of the 220-foot Arcade Trestle and the 384-foot CPRR American River Bridge at Sacramento [20].

JUDAH'S DEATH AT 37

Shortly after filing this report (in October) Judah sailed for New York and while crossing the Isthmus of Panama, contracted Yellow Fever, from which he died on November 2, 1863 in New York at the age of 37. After Judah's death, engineering continued under his 33-year-old former assistant, now Acting Chief Engineer, Samuel S. Montague. However in most construction matters, the driving force and strategic planning of CPRR Director Charles Crocker became supremely important.

18. Theodore Judah, *Report of the Chief Engineer of the Central Pacific Railroad of California* October 22, 1862. (Sacramento: H. S. Crocker, 1862), pp. 29--31. Here Judah also mentions a maximum snow depth of 13 feet at the summit and a maximum depth for a single storm of 3 or 4 feet -- not the 10 feet in four days of 1867 noted by Gillis. Judah appears to have had no true concept of the great danger and power of avalanches.

19. Deck style railroad bridges, with the tracks on top of the supporting trusses, were a bit cheaper to build and allowed for lower foundations while maintaining the required track grade. Bridges with the tracks inside the trusses were used when crossing streams where high water might reach the bridge. This latter style of wooden railway bridges was easier to maintain, but the wood trusses could be set on fire by sparks from passing locomotives.

20. Theodore Judah, *Report of the Chief Engineer upon...First Division of Fifty Miles of the Central Pacific Railroad of Cal. July 1st, 1863* - (Sacramento: James Anthony & Co. 1863), pp. 21--25.

(Fig. 5) Alfred Hart: No. 148 *View of American River Bridge, near view-3 miles from Sacramento*. Taken on March 16, 1865 during an excursion to celebrate the arrival of the new freight locomotive CONNESS which can be seen in the enlarged inset, loaded with men at the far end of the bridge. (At the near end is the HUNTINGTON.) A close view of the CONNESS appears in (Fig. 33) on page 56. The bridge was designed by the CPRR chief engineer, Theodore Judah, and completed in 1863. Later it was destroyed by fire, and Arthur Brown (who built 37 miles of snowsheds in six months) had it repaired and open for traffic in *40 hours*.

Standing in the foreground is Judge E. B. Crocker looking at the small locomotive HUNTINGTON and the ladder at the extreme right used by Hart to bring his camera down from the trestle to take this picture. This trip is also mentioned on page 59 in column one.

William Hood, who was closely associated with Crocker during construction, said he had the gift:

> ...of sound common sense. I never heard Mr. Crocker reproving or speaking to any one except in encouragement and in a manner to increase the man's self respect and instill a desire to continue in his good opinion. He was able to convince those working under his direction that he believed they were doing their best, and they did it.... [21]

In 1864, about the time Hart started making stereographs for the CPRR, James H. Strobridge was appointed superintendent of construction, and he remained in day-to-day charge of the actual work until the final spike at Promontory. He was a tall, hard-driving New Englander, whose vocabulary was rumored capable of removing the hide of a mule at 40 paces. When Charles Crocker was faced with a serious shortage of laborers in 1865, he proposed using Chinese workers for railroad construction. Strobridge at first objected, but after working with them for a short time he became their great champion, and trained them for most construction jobs.

Almost as soon as construction began, the need for extra work on certain portions of the road required crews to be sent far in advance of the actual end-of-track. This stretching forward, increased over time and by early 1865 when the railhead was only a bit above Auburn, camps had already been established and work begun on the larger projects all the way to the Summit Tunnels, 60 miles beyond. At this time Hart used his photo-wagon to take a number of scenes beyond the end-of-track which he later published. Some examples of these early construction stereographs are found in Appendix A: Nos. 70-72, 80-92, 116-125, and 196-204. It is interesting that the transport of his photo-wagon on a flatcar to reach the railhead, may well be the first photographed examples of an off-rail vehicle accomplishing what is now referred to as "piggy-backing."

Until June 19, 1866 when Congress lifted the ban, The Pacific Railroad Act limited the Central Pacific from building beyond a point 150 miles east of the California border. Up until that time, it was expected that the terrible difficulties in the Sierra Nevada Mountains would hold them back while the "easy" work facing the Union Pacific would permit both of them to reach the California border at about the same time.

It gradually became obvious that Congress had underestimated James Strobridge's "dedicated fury"[22] and the incredible drive of the railroad construction team assembled by Charles Crocker. (For a close view of some of these men, see Fig. 2.)

In addition to enormous cuts and fills, bridges, and retaining walls, the CPRR had to bore a total of 6,213 feet in 15 tunnels while crossing the Sierra Nevada Mountains. All of the CPRR tunnels were completed well before the Union Pacific commenced the boring of the four tunnels with a total length of 1,792 feet on their section of the Pacific Railroad.

The longest CPRR tunnel was 1,659 feet and the shortest 92 feet. The majority were in hard granite, which is often thought of as being similar to marble or limestone. It is actually a very common igneous stone even harder than steel or glass, and impervious to virtually all chemicals. It can be polished to a mirror finish, and can bear a compressive load of over 1,000

21. George Kraus, *High Road to Promontory*, p. 297.

22. Wesley S. Griswold, *A Work of Giants*, p. 91.

tons per square foot. A block of granite 2 x 3-1/2 inches (the size of a business card) would support a 46-ton CPRR locomotive without being crushed. Because of granite's amazing durability, 125-year-old drill holes made in split boulders at the summit are still sharp edged, and look only days old.[23]

CPRR TUNNELING METHODS

The excavation of a tunnel was started by laying out a staked line beginning at the outside of both ends and extending over the top of the hill to be pierced. This was immediately followed by making a cut in the hill toward the mouth of the tunnel until reaching a vertical face the full size of the bore. This initial open cut was a little wider than the planned tunnel width and the bottom of the cut slightly below the tunnel floor. The vertical back of the cut became higher as the cut entered the hill and when its height exceeded the height of the bore (about 20 feet), driving the tunnel was commenced. The tunnel bore was usually a rectangle 16 feet wide by 11 feet high surmounted by a half circle of 8 feet radius. The completed bore thus had somewhat the shape of the end-view of a loaf of bread.

After clearing the vertical face, the real tunnel was begun at the upper, or rounded portion called the "heading," and this area was kept about 20 feet ahead of the lower area called the "bottom." This process allowed the all-important survey lines, which kept the bore on course, to be maintained safely overhead by spads--a sort of nail with an eyelet in the head--accurately set in wood plugs driven into holes drilled in the ceiling. As construction progressed, the floor of the heading was kept about 11 or 12 feet above the floor of the tunnel and provided a working area near the ceiling without the use of scaffolding.

23. Granite is so immutable that archaeologists cannot date artifacts made from it except by association with other things found nearby. Granite exposed to alternate wetting and freezing will slowly suffer surface degradation, but polished granite 5,000 years old has survived unaffected in the dry climate of Egypt since the Old Kingdom.

(Fig. 6) Rare photograph of a tunnel "heading". Enlarged from a portion of Hart, No. 197, *Summit Tunnel before completion*.

Details of underground surveying by the CPRR engineers under Montague are sketchy, but contemporary surveyors often sighted at weighted wires hanging from spads in the ceiling with a candle held behind the wire for precise location in the dark. A more sophisticated device for long underground surveys, was the Coxe Plummet-Lamp, which contained a small kerosene lamp to illuminate a tiny self-contained sighting post. It too was hung from the ceiling, using gimbals and brass chains.

ABOVE: (Fig. 8) Hand-drilled blast hole in Summit Tunnel which resulted in a perfect splitting of the stone (right down the middle of the hole). This example of Chinese drilling skill has been passed at close range by possibly a million passengers who never saw it in the darkness of the tunnel. (MBK photo)

LEFT: (Fig. 7) Bloomer Cut near Auburn, California in 1990. This cut is over 600 feet long in hard, cemented stone. It delayed the CPRR construction for many months and James Strobridge lost one of his eyes to a delayed blast here. (MBK photo)

By means of such devices, in 1875, the Brookfield Tunnel in an Ohio coal mine was bored 4,016 feet through 43 turns or angles with a final alignment error of only 6 inches. [24]

Surveying the absolutely straight CPRR 1,659-foot-long Summit Tunnel was rather simple by comparison, and the headings met with an error of less than 1/2 inch.

A central vertical shaft was dug to allow this tunnel to be worked simultaneously from four faces (further described in footnote 129, page 160, Appendix B). The alignment of this central portion required particular care as the line-of-sight had to be carried 73 feet down a shaft only 12 feet wide.

The surveying of each of the longer CPRR Summit Tunnels was similar. As soon as the heading had penetrated 25 or 30 feet, very accurately located spads were set overhead and these formed the basis of alignment for the remainder of the tunnel. This latter step was necessary because of the heavy snow outside which halted the use of exterior backsights.[25]

Rock encountered in this work was broken by blasting.

Black powder blasting was accomplished by hand drilling holes of 2-inch diameter about 2 to 3 feet deep (Fig. 8) and where possible, at a downward angle.[26] Down-sloping holes allowed the powder to be poured in, while an upward sloping hole required the powder to be loaded in a metal or paper canister. The holes were filled to 1/3 the depth of the hole with granular black powder, a length of fuse inserted, and the remainder of the hole packed with dry clay, sand or even hay, and tamped until closed tight.

Tamping was done with a wood pole or brass bar. A steel bar could strike sparks from the sides of the hole and ignite the charge prematurely. The fuse burned at about three feet per minute and the inner end was placed at the middle of the charge for maximum effect. Nearly simultaneous discharges of

24. Henry S. Drinker E. M., *Tunneling, Explosive Compounds, and Rock Drills with a History of Tunneling from the Reign of Rameses II to the present Time. With about 1000 illustrations in the text and several large folding plates.* (New York: John Wiley & Sons, 1878), p. 905. A fascinating book containing in 1,031 pages more than anyone wants to know about digging tunnels up to 1878. The innumerable woodcuts are distributed throughout the text. The phrase of "about 1000 illustrations" on the title page at first seemed unusual, but after looking through the volume, perfectly appropriate.

25. Hart took many pictures at the entrances of tunnels, but only two of interiors. The excessively long exposure required and the ongoing rush of the workmen (and after the completion, the trains) may have been the main reason for so few interior photographs. The word "Portal" applied to a tunnel entrance infers the presence of a decorative facade, which the early CPRR builders did not take time to construct.

26. Hand drilling involved placing a steel bar (the drill) with its sharp, hard point against stone, and striking the other end with a hammer, while turning the drill in the hole between blows to produce a round hole. In overhead work and in confined spaces, "single hand" drilling was employed using a 2-1/2 to 6 pound hammer and holding the drill with one hand and striking with the other. Some miners in Europe were reported using 9-pound hammers for full eight-hour shifts, but that was considered unusual.

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or general work on the CPRR "two-hand" drilling was used where one worker held and turned the drill and another struck it with a 12-to-16-pound hammer. In Appendix A, No.119 shows a Chinese laborer in a then common but terrifying position, in which he sat on a rock holding the drill between his legs while his teammate did the striking. This same pose appears in other contemporaneous tunnel photographs.

multiple blasts were often used for greater efficiency, because in a confined space, the smoke from several blasts cleared in about the same length of time as that from a single explosion. Setting fuse lengths and the order of lighting thus required some exact calculations. Blasting in those days, like making fine beer, was both a science and an art; so figures given here are merely averages which varied according to the taste of the individual foremen.

Through the strength, type, and placement of the charges, a skilled powder man could split a boulder the size of a bus into two unshattered halves or reduce it to gravel fine enough to load with a shovel.

The CPRR tunnel workers were divided into gangs of about 107 men per working face (the heading and bottom together). These were further divided into three eight-hour shifts of 33 laborers, one blacksmith to sharpen drills, one helper, and one horse and driver to pull loaded wagons of broken rock out of the tunnel. The two foremen each worked 12-hour shifts, supervising one eight-hour shift and half of another. The payroll data in Gillis's report (see footnote 32) indicate that all the tunnel workers on the larger tunnels were Chinese and the foremen, blacksmiths, and helpers, Caucasians.

While neither the problem nor its solution is mentioned in contemporary reports, melting snow water must have been a problem while drilling the west end of all the Summit Tunnels (Nos. 6 through 13) as they sloped down to the east at 5/8 inch per yard of length. In August 1994, after a very dry winter, water still leaked into the tunnels at many spots, and after the terrible winters of 1866 and 1867, it must have come in torrents.

NITROGLYCERIN ADVENTURES

The long Summit Tunnel (No.6) was obviously the most difficult both in time and effort, and after 396 twenty-four hour days using black powder, their average progress was only 14 inches per day in the headings[27]. At this point Charles Crocker decided to employ nitroglycerin. It had been patented in the United States by Alfred Nobel on October 24, 1865 and promptly developed a reputation for great power and a nasty propensity to explode at unexpected times.

Crocker and Strobridge may well have learned of nitroglycerin because of an incident at the San Francisco office of Wells Fargo & Company involving a salesman's sample sent by Nobel from Hamburg to his California agent:

> [In April 1866] ..explosion occurred in the office of Wells Fargo & Co., by which eight persons lost their lives. The explosion involved a further loss of a quarter million dollars. A man passing by Wells Fargo & Co. office heard one of the employees address a man riding past on horseback, saying 'Doctor we have got a case of glonoin oil and it seems to be smoking, I wish you would step in and advise us what had better be done with it'. The doctor (Hill) dismounted requesting a passer-by to take charge of his horse and walk it up and down the block, the animal being too high spirited to stand without an attendant.
>
> Scarcely had the person in charge gone a block from the office when the explosion occurred. It can only be inferred that in breaking open the case to discover the cause of the leakage of red fumes, the Nitro-Glycerine was exploded.[28]

Nitroglycerin is a clear, odorless, oily liquid having a pleasant, sweet taste. It is poisonous when inhaled, swallowed,

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27. In a personal conversation about modern tunneling methods on July 23, 1994, Edmund Shea, vice president of J. F. Shea Company mentioned that a circular tunnel 20 feet in diameter could now be bored in hard granite at around 50 feet per day. His company has constructed huge tunnels all over the U.S. and this estimate was based on the use of an immense boring machine with which they have had extensive experience. Thus, with this machine and a small crew, the 1659 foot Summit Tunnel could have been holed through in 33 working days, plus a few days for cleaning up (and without the pervasive shattering of the surrounding rock caused by blasting).

28. George M. Mowbray (Operative Chemist), *Tri-Nitro-Glycerin* (North Adams, Mass.: James T. Adams & Son, 1872), p. 4. This is the first American treatise on this subject and describes in exact detail Mowbray's manufacturing methods, and his first introduction of experimental quantities of nitroglycerin in the construction of the Hoosac Tunnel, N.Y. in October, 1866. The Hoosac Tunnel builders did not use it for regular construction until 1868. The Central Pacific began the regular use of nitroglycerin in the Summit Tunnel beginning in January 1867 and were probably the first to do so in the United States. Mowbray's book is illustrated with six albumin stereo prints taken by Mr. L. Daft.

or introduced into the body through the pores, producing headaches and sickness. Quality nitroglycerin is not sensitive to friction or moderate percussion. If placed on an anvil and struck with a hammer (not recommended), only the particle receiving the blow explodes, scattering the remainder. In Germany, an experiment showed that nitro-glycerin confined in containers of glass, tin, and wood did not explode when dropped 85 feet onto rocks. These remarks apply to very pure, well-washed specimens, not likely to decompose. *Impure* nitroglycerin, contained in a can at Yonkers, New York, was exploded by the impact of a rock thrown by a boy.[29]

Nitroglycerin is made by treating glycerin with nitric acid in the presence of sulfuric acid, and its chemical formula is $C_3H_5(NO_2)_3O_3$. It is heavier than, and insoluble in, water and the excess acids resulting from its manufacture are removed by repeatedly passing it through a water bath. Washing can also be accomplished by passing water or a mixture of air and water upward through the nitroglycerin. The water is continuously drawn off at the top, leaving the purified product at the bottom of the container. Unlike black powder which has a slower effect and follows the line of least resistance, nitroglycerin explodes almost instantly in all directions with no regard for the resistance met. It is particularly effective in hard rock which it tends to shatter into small, easily loaded pieces. Since nitroglycerin was much more powerful than black powder, smaller holes could be drilled, and being oily, it worked perfectly in wet rock or even under water.

Nitroglycerin freezes at 45 degrees Fahrenheit and had to be warmed in winter before pouring into the blast holes of the Summit Tunnel. One can imagine the attention lavished on this process in order to avoid overheating to the point of ignition. It is unsafe to bury quantities of nitro-glycerin because it may later react with its container or chemicals in the soil to become unstable and easily exploded. The usual method of disposal was by burning in the open without a restricting container. Since Crocker had no desire to see parts of his new railroad to the west blown up while transporting the liquid explosive, he arranged for it to be manufactured at the summit as needed. For the remaining 655 days, using nitro-glycerin, progress in the headings of the Summit Tunnel increased to 22 inches per day. In the bottoms it was even more effective, increasing progress from 17 inches to 53 inches per day. Despite its advantages, Crocker did not allow nitroglycerin to be used anywhere on the railroad after completion of the Summit Tunnel in November 1867.

Because they only manufactured the nitroglycerin as needed, there was no disposal problem, and the unused ingredients which were caustic, but nonexplosive, could have been resold.

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29. Henry S. Drinker, *Tunneling*, pp. 64-65, mentions several other exciting tests including how a man in a hurry with a sleigh-full of explosive found out frozen nitroglycerin was harder to explode than if in liquid form. The author points out that one gram (1/30 ounce) of nitroglycerin produces 2,000 cubic centimeters of gas at a final temperature of 9,392 degrees F. and a total pressure of 26,000 atmospheres (390,000 pounds per square inch). By comparison *TORPEX*, used in the war heads of World War II American submarine torpedoes had a detonation pressure of over 4,000,000 pounds per square inch.

Unlike black powder, nitroglycerin is not normally detonated by a direct flame from the fuse. A blasting cap containing fulminate of mercury ($HgC_2N_2O_2$) was crimped on the end of the fuse and its sharp detonation caused the nitroglycerin to explode. In the absence of a crimping tool a gentle bite with the teeth was occasionally used to secure the copper cap to the fuse end.

ABOVE: (Fig. 9) Engineering profile of the CPRR's first seven Summit Tunnels (Nos. 6 through 12) sloping down from the actual summit at the left edge of the illustration. The vertical (distance) lines are 100 feet apart and the horizontal (elevation) lines are five feet apart, resulting in the pointed appearance of the mountains. The great retaining wall between tunnels 7 and 8 (shown in Fig. 11) was built across a small creek formerly used to reach Donner Pass. (From John R. Gillis *Report on the Paciёc Railroad Tunnels* to the American Society of Civil Engineers, January 5, 1870. Courtesy of Nigel Croft, Document Services Manager, Engineering Societies Library.)

LEFT: (Fig. 10) Ice in Donner Summit Tunnel, looking East at tunnel 8 in January, 1993 (a very mild winter). The railroad men used shotguns fired from the rear of work trains to shoot down the massive icicles (up to 3 feet thick). (MBK photo)

(Fig. 11) Great wall between Donner Summit Tunnels 7 and 8 started in 1866 and continued under a snow cavern through the winter of 1866/67 when 44 feet of snow fell. The Chinese workers carefully laid the lower courses from both sides in good weather, but the upper courses were built inside the cavern on the back of the wall making alignment of the face very difficult. (MBK photo)

ABOVE: (Fig. 13) Old snowshed timbers east of tunnel 8. The 20 degree angle roof frame can be seen at right foreground. Taken in August 1994. (MBK photo)

LEFT: (Fig. 12) Portion of Hart No. 202 taken from upper left of Fig. 11 which shows the construction of the lower part of the great wall between tunnels 7 and 8. Hart made this photograph in late fall of 1866. Light snow was already present and the steam engine was operating in the central shaft house at the extreme top of the picture. At the bottom a horse and wagon can be seen coming out of tunnel 8.

The Summit Tunnels Nos. 6 through 10 completed by the CPRR in 1867 remained in continuous use until July 1993 and the rails and track hardware were finally removed between July 11, and August 5, 1994.[30] (This did not end rail travel over the Donner route as a more modern and much longer parallel tunnel had been built in about 1910, and remains in use.) The rails extended 119 miles to Truckee on April 3, 1868, and from that point construction speeded up across the level expanse of Nevada until advances of two or three miles in a day were common.

30. Although a crew of hundreds was used by Strobridge to lay the original 56-pound rails (that is 56 lbs. per yard), in August 1994, Tim Majdik, the foreman of the last track crew to work in those tunnels removed the rails with about 10 men, and special machines to pull out the spikes. The 136 pound-ribbon rail (modern rail delivered in quarter mile lengths, and welded at the site into lengths up to a mile between bolted joints) was cut into 700-foot lengths and dragged out of the tunnels by a huge wheeled tractor. Some of the rail had been installed as late as 1988 and was saved to be used in other parts of the Southern Pacific system (successors to the CPRR). Older rail went to sidings and switch tracks.

BUILDING THE WORLD'S LONGEST BARN

In 1868, despite rapid construction on the plains, the Central Pacific was still facing a major problem in the High Sierra that Crocker, Strobridge and Montague had felt they understood--snow. They, as well as all the directors had been born and raised in New England where snow was always a consideration. They knew about blizzards, 30-degrees below zero temperatures, and snow in city streets drifting up to 3 feet deep. How bad could Sierra snow be where the temperature seldom dropped below zero? The answer was given to them in

the winter of 1866/67 and the answer was -- Beyond Belief! The winter of 1865/66 provided a preamble of what was to come; the rain in the foothills was so heavy that the stage coach en route from the railhead at Colfax for

(Fig. 14) Spikes and tie plates from Summit tunnels, 1994.

Virginia City was stuck in the mud at Gold Run and left standing in the street for six long weeks. All wagon traffic ceased and construction supplies moved with great suffering and difficulty, on the backs of mules. By November 1866, the railhead had climbed to Cisco and the 1866/67 winter was even worse than the previous one. (Figs. 80 and 81)
Civil engineer John R. Gillis reported:

> In November and the early part of December [1866] there were several snowstorms, just enough to stimulate without denying the work. The rough rocky sides of Donner Peak [Hart's "Crested Peak"] soon became smooth slopes of snow and ice covering the trail from tunnel 8 to 9: it remained impassable until spring....Snow storms, 44 in number, varied in length from a snow squall to a two week gale, and in depth from 1/4 inch to ten feet....The heaviest storm of the winter, began February 18th [1867] at 2 p.m., and snowed steadily until 10 p.m. of the 22nd, during which time 6 feet fell." [The total snowfall that winter was 44 feet and 7 inches] "Of course these storms made the road impassable even for sleighs. They were opened by gangs of men, kept for that purpose, with heavy ox sleds. The snow when new fallen is very light, so that a man without snowshoes would sink to his waist or shoulders. Into this the oxen would flounder, and when they lay down, worn out, be roused by the summary process of twisting their tails. [31]

Obviously teams of exhausted oxen could not precede trains through the snow-bound passes. Worse, the huge new snow plows built in 1866 could not be forced through the immense drifts--even with eight or ten locomotives, and the 2,500 men employed in shoveling the snow from the tracks could not keep the line open more than half the time.
Despite these daunting problems, Charles Crocker had not totally lost his sense of humor when he placed the following advertisement on page 5, column 6 of the January 20, 1868 *Sacramento Union*:

TEAMSTERS AHOY !

I desire to contract for the hauling of 2000 Tons
of Iron from Cisco to Coburn's Station to be delivered in 90 days.
Snow all the way and Splendid Sleighing ! A Liberal price will be paid.
Chas. Crocker, Superintendent, CPRR

His effort was evidently successful as the notice appeared only on that one day. (Coburn's Station was on the Dutch Flat Wagon road near Truckee, and 2000 tons of rail would build 20 miles of track.
Hart is known to have photographed only a handful of scenes in deep Sierra snow, one being No. 207 showing a snowplow at Cisco. A number of reasons can be suggested in addition to the obvious discomfort of just being there. Wet-plate photography was brutally difficult in freezing temperatures, travelling on the crowded railroad to the rail head may have been restricted at that time of year, and it is highly likely that Hart used the winter respite to complete his photographic work and to prepare and market his stereographs. A winter sojourn in the valley would also explain the almost universally leafless trees in his Sacramento views.
With all these snow problems, something radical had to be done to ensure the passage of supplies to the crews on the Nevada desert during the crucial winter months of 1868/69, and also to accommodate the new transcontinental traffic following the joining of the CPRR with the Union Pacific. With great reluctance the directors agreed that they must take a step unheard of in railroading before. They would have to build nearly 40 miles of heavy wooden sheds covering large parts of

31. John R. Gillis, *Tunnels of the Paciëc Railroad, A Paper read before the American Society of Civil Engineers Jan. 5, 1870* (New York: Transactions, American Society of Civil Engineers, Volume I, 1870), p. 153. (Information from a photocopy kindly provided by Nigel C. Croft, Document Services Manager, Engineering Societies Library, New York City.) For those interested in early railroad construction history, this 19 page article contains a wealth of information on methods and costs. For instance each tunnel face (heading and bottom together) used 150 lbs. of candles and 1,500 feet of fuse per month.

the railroad eastward from Blue Canyon to Coldstream Valley on the other side of the summit.
In addition to the main problem of snow, the sheds would protect the rails from rocks falling from the cliffs above. In 1990, a stone was seen (about half the size of an automobile) which had fallen through the modern concrete roof of the snowshed between tunnels 8 and 9 below Donner Peak. The maintenance supervisor who was driving the high railer (a pickup that can run on rails) didn't seem at all surprised and merely observed that the rock wasn't touching the track and probably weighed no more than two or three tons. [32]

In 1867 the job of building the snowsheds fell to Arthur Brown, Superintendent of Bridges and Buildings, a 37 year old Scotsman. He said later:

It was decided...that the only means of protecting the road was by means of snow sheds and galleries [at first Hart called them "snow coverings"], although the expense of building a shed nearly 40 miles in length was appalling and an unprecedented extra in railroad construction. In the summer of 1867 we built some experimental sheds. The snow shed building was commenced *in earnest* in 1868.

The simple words "in earnest" when used by a construction superintendent on the Central Pacific had meaning that can only be described as without modern comparison.
Because of the snow and mud, only about six months of the year could be used for building. The tracks inside the sheds had to be cleared for the passage of up to 40 trains each day, and the local sawmills had such an insufficient capacity, that round timber for posts had to be cut nearby in the woods and brought up on sleds. (See Appendix A, views No. 246 to No. 254) Brown's description continued:

As the road was then rapidly progressing up the valley of the Humboldt, it became a matter of the most vital importance that the sheds should be so far finished that the supplies and building materials for the construction ahead should not be interrupted...We, therefore, had to gather men from all quarters and pay high wages: carpenters, $4.00 per day; and suitable laborers $2.50 to $3.00. We employed about 2,500 men, with six trains with locomotives distributing material...The snow sheds and galleries were finished in the fall of 1869. In them was used 65,000,000 board feet of lumber and 900 tons of bolts and spikes. The total length of sheds and galleries was, when finished [in 1869], about 37 miles. [33]

More sheds were added later bringing the total to nearly 40 miles. Since 1960, the milder winters, more powerful snow-plows, and the installation of reinforced concrete snowsheds have resulted in the removal of miles of the old wooden sheds. The heavy old timbers quickly disappear where there is public access, but in a few lonely locations, they remain in piles 10 to 15 feet high and are still visible on the mountains across Donner Lake from its north shore (See Fig. 13).
Hart appears to have been very interested in the snowshed construction and published at least three variations of his No. 246, "Constructing Snow Cover," and many other views of the open frames before the roof covering was installed.
The lighter structures with the round posts started around Emigrant Gap, and the extremely heavy square-sawn posts were used near the summit where avalanches could be expected. For a photographer on site at the right moment, the framed, but as yet unroofed, sheds allowed plenty of light for photography and provided unexcelled opportunities for Hart to demonstrate depth and composition in his stereographs (See Fig. 38).

RACING TO UTAH

In the great rush to Promontory, CPRR crews were actually grading in Palisade Canyon 300 miles ahead in eastern Nevada as the railhead neared Reno.
Nineteen years later in describing this effort, James Strobridge said:

32. Noted on a visit by this writer on July 23, 1990.

33. Roscoe Conkling and William Shipman, *The Central Pacific Railroad Company, Testimony and Exhibits before the Pacific Railway Commission* (New York: Henry Bessy, 1887), pp. 33-34. Arthur Brown, Affidavit to the United States Railroad Commission at San Francisco in 1887/88.

It was necessary to have the heavy work done in the Palisade [Ten Mile] Canyon done in advance of the main force: and 3,000 men with 400 horses and carts were sent to that point, a distance of 300 miles in advance of the track. Hay, grain and all supplies for these men and horses had to be hauled by teams over the deserts [from Truckee] for that great distance, there being no supplies to be obtained on the entire route. [34]

Despite problems of this nature on the desert, construction between Newcastle (California) and Truckee (3 miles east of Donner Lake) had been infinitely harder. With James Strobridge in charge and using an average of 11,000 men, it still took 38 months (February 1865 to April 1868) to complete the 88 miles over the Sierra summit. With a work force averaging only 5,000 men, the railroad was completed from Truckee, California, to Promontory--a distance of 571 miles--in 12 months and 27 days. Strobridge is said to have remarked that if the Union Pacific had never existed, the CPRR could have completed the 1086 miles from Promontory to Omaha in less than eighteen more months.

CROCKER'S BET TO LAY TEN MILES IN ONE DAY

In a celebration strangely reminiscent of the review in Washington D.C. of the victorious Union Armies on May 23 and 24, 1865, Charles Crocker and James Strobridge planned a stunning demonstration of teamwork for April 28, 1869 on the lonely Utah desert between Monument Point and Promontory .

(Fig.15) Hart No. 246(a) Arthur Brown on snowshed by Tunnel 8.
(Fig.16) Hart No. 315 Water train near Humboldt Lake, in the Nevada desert. The CPRR tank cars carried water for locomotives and camps.

34. Conkling and Shipman, *The Central Paciëc Railroad Company*, 1887, p. 32. James Strobridge, superintendent of construction, under oath before the United States Pacific Railroad Commission at San Francisco.

(Fig. 17) Alfred Hart: No. 338 *First Construction Train passing the Palisades, Ten Mile Canyon.* Taken in December 1868 about 435 miles from Sacramento. The track was just laid, and the hardworking locomotive had the decorative front of its smokebox missing.

For the last time, almost the entire remaining body of the CPRR's mighty construction force was gathered for this day, intending to set a record that would stand forever. Of course this was an era noted for stupendous construction achievements; for example during the Civil War the Confederates totally destroyed the 600-foot military railroad bridge over Potomac Creek on the Aquia Creek & Fredricksburg Railroad. Two days later, Captain A.J. Russell photographed it just after it had been rebuilt by the U.S. Military Railroad Construction Corps in *40 hours*.[35] Some veterans of that effort may well have been working for the CPRR, but even they had never seen an accomplishment such as that proposed by Crocker and Strobridge. In a single 12-hour day they would place the ties, lay and spike down the rails, build the telegraph line, and ballast 10 miles of track!
At 7:00 a.m. on April 28, 1869, the first of some 80 cars of rails was unloaded and when the final whistle blew that evening, they had completed 10 miles and 56 feet of new railroad (see also Appendix B, page 165, footnote 141) As the reporter for the San Francisco *Bulletin* wrote that day about the construction:

The scene was an animated one. [a world class understatement] From the first 'pioneer' to the last tamper, about two miles, there was a line of men advancing a mile an hour; iron cars with their loads of rails and humans dashed up and down the newly-laid track; foremen on horseback were galloping back and forth. Keeping pace with the track layers were the telegraph construction party. Alongside the moving force, teams were hauling food and water wagons. Chinamen (sic) with pails dangling from poles balanced over their shoulders were moving among the men with water and tea." An Army officer remarked to Charles Crocker: "It was just like an army marching over the ground and leaving the track behind them.[36]

Only a short section of track remained to be built, and by April 30th the reporter for the *Alta Californian* wrote: "The last blow has been struck on the Central Pacific Railroad and the last tie and rail were placed in position today. We are now waiting for the Union Pacific to finish their rock cutting."
The diary of Captain John Charles Currier who was with his regiment on the first train through from Omaha to Sacramento, disclosed a telling difference in efficiency between the UP and the CPRR. On the UPRR it took him three full days to cover the final 40 miles to Promontory, including riding in a set of cabooses pushed one at a time across an all-too-shaky trestle. He earlier noted that the UPRR tracks were so uneven that he fell down while trying to get a drink of water in a moving passenger car. His confidence in the general management of the UPRR was further shaken when he learned that the vice president of the UP had his private car chained to the rails until workers were paid. In contrast, when Captain Currier had transferred to the train on the Central Pacific side after the joining ceremony, he left around midnight on May 10th and arrived in Sacramento (690 miles away) only 59 hours later.[37] Captain Currier wrote in his diary:

At Humboldt Wells, Nevada Territory, 165 miles from Promontory. We are making excellent time. There is a perceptible difference in the running time from that of the U.P.[sic] We go faster....We run thirty miles per hour with very few stops. The Centrals carry their water along with them in immense tanks for it is very difficult to get water here. The grading of the road is perfect: for the last 80 miles we have run as smooth as a floor.
With all this we ran like lightening at a frightful speed. Made 200 miles last

35. Joe Buberger and Mathew Isenberg *Russell's Civil War Photographs* (New York: Dover Publications, 1982), p. 111. In 1869, the UPRR had laid seven miles of straight track
in one day, but it took them well over 12 hours. It was rumored that the UPRR president Thomas Durant was so sure the CPRR men would fail that he bet Crocker $10,000 his crew could not lay the 10 miles of track in a regular 12-hour day.

36. Wesley Griswold, *A Work of Giants,* p. 311.

37. Governor Leland Stanford's party arrived back in Sacramento from Promontory at 5:30 a.m., May 12, 1869 after a trip of 36-1/2 hours, including three hours of delays for water and fuel. The railroad president's train would obviously receive priority over any other.

night. Some times our car, it being the rear one would snap as if it was a whip. Several of the officers became alarmed at our speed. On, On we rushed without a stop....All remark on how well this road is built, certainly fifty percent better than the U.P....The "C.P's" don't mean to keep us long on their road. They halt for nothing and seem impatient if we wish to stop for coffee. Somewhat different from the 'U.P.' [38]

It is unfortunate that the informal construction methods employed by the UP were later attributed to the CPRR as well. The better construction provided by the CPRR, as noted by Captain Currier, can also be clearly seen in contemporary photographs. If one sees sawn ties with square ends, it is most likely CPRR track, and if round ties flattened on one side with pointed ends, UPRR track. Ties of this type were often used on the military railroads of the Civil War, and may have influenced their use on the UPRR where many former Union soldiers were employed.

A DAY OF NATIONAL REJOICING

The almost universal pride and joy felt by the nation regarding the joining of the rails at Promontory was certainly equal to that felt at the end of World War II. A telegraph wire was attached to the silver hammer driving the last (*gold*) spike while every telegraph instrument in the nation was kept silent.[39] When the fateful "click" was heard, for the first time in United States history, the whole nation knew a momentous event had occurred at the very instant it happened. The silver-plated hammer which drove in the last spike was held by Leland Stanford, the man who six years and four months before had turned the first spade of earth to begin the construction of the Pacific Railroad 690 miles to the west in Sacramento.

The spanning of the United States by rail elicited many forms of praise, one of the more remarkable being a woodcut used as the frontispiece of *Crofutt's Trans- Continental Tourist* in 1874. The Goddess of American Progress floats westward in revealing diaphanous garb while bearing a book marked "Common School" and a roll of telegraph wire (Fig. 20). This was the only occasion where the United States Mint issued a commemorative medal at the time of the event, and a century later, it was still considered so important that its centennial was also commemorated by another issue.

In addition, on May 10, 1944, just 27 days before D-Day, the United States Post Office issued a special stamp to commemorate the seventy-fifth anniversary of the joining of the rails at Promontory. The allegorical scene depicted was not taken from any particular photograph, but featured the CPRR's locomotive JUPITER, whose number "60" was clearly visible.

Even the world of music made contributions, an example being a happy song by Henry P. Work entitled "Crossing the Grand Sierras." © Brainard Publishing,'76.

The completion of the rails from coast to coast had a huge impact on the future of the United States. It did not, as expected, result in the country becoming a conduit for freight to and from the Orient. (The construction of the Suez Canal changed the cost structure of that trade and maintained it in European ships.)

(Fig.18) Hart No.317 *End of track near Humboldt Lake*. Workers demonstrating their jobs during a visit by dignitaries (See pg. 15).

(Fig. 19) Hart's full page advertisement in the 1870 Sacramento

38. Joseph A McGowan, *First Train West* (Sacramento: Sacramento County Historical Society, 1969), Volume 15 No. 3, pp. 31-32, Diary of Captain John Charles Currier, USA.

39. The actual joining of the rails culminated in placing a polished tie of California Laurel under the last rail. A hole had been drilled in this tie to accommodate the last spike, which was an exact duplicate, in solid gold, of the iron spikes driven into the regular ties to hold down the rails. The gold spike was engraved with the names of the officers and directors of the CPRR, the words "May God continue the unity of our country as this railroad unites the two great oceans of the world" and on one face, "The last Spike. The Pacific Railroad--Ground broken January 8th, 1863; completed May _ 1869. The exact date was to be engraved later. The Gold Spike weighed about 18-ounces and a further description appears in Kraus, *High Road to Promontory*, pp.263-264.

City Directory compiled in 1869. When Hart left Sacramento, Frank Durgan, who later published Hart views, used the same address.

(Fig. 20) *AMERICAN PROGRESS* (Frontispiece) George A. Crofutt, *Crofutt's Transcontinental Tourist* (New York: G. W. Carleton & Co. 1876). The author designed the picture describing the central figure as "a beautiful and charming female, bearing on her forehead the 'Star of Empire'."

UNITED STATES MINT MEDAL FOR COMPLETION OF THE PACIFIC RAILWAY

Engraved by William Barber. Mint catalog No. 623.
The actual diameter is 1-3/4 inches.

(Fig. 21) OBVERSE: Classic head of President U. S. Grant, in exergue "The Oceans united by Railway"
The moment after the Gold Spike was driven the telegraph transmitted "done" followed by "The last rail is laid. The last spike is driven. The Pacific Railroad is completed!" President Grant made the official announcement from the White House.

(Fig. 22) REVERSE: The legend reads: "EVERY MOUNTAIN SHALL BE MADE LOW"

The quotation is from Isaiah, Chapter 40, Verse 4, "Every valley shall be exalted, and every mountain and hill shall be made low: and the crooked shall be made straight and the rough places plain." (Citation courtesy Miles Snyder, Esq. of Sacramento.)

In an address before the American Society of London on Thanksgiving Day, 1928, Stanley Baldwin, the prime minister of Great Britain said: "As the Pacific Coast became settled, the engineer came into his own and the railroad was thrown across the continent. By that means alone you prevented the possibility of a separate American nation growing up beyond the Rocky Mountains."[40]

Interestingly, the railway helped end the war with the Native American Indians. During the years 1864 and 1865, the Quartermaster's department alone spent $28,374,228 for supplies and their transportation for use against the Indians.[41] As the chief cost was transportation, and estimating it to be at least 60 percent of the whole, it would have averaged over $8,500,000 per year. For comparison, in 1887 for transportation of troops, passengers, supplies and other freight, the Central and Union Pacific together charged the government only $169,603.

Freight rates at points touched by the railroad dropped dramatically. Earlier, in 1863 the La Porte (Sierra County) *Mountain Messenger* noted that a 100-pound bar of Swedish Iron had been received by the blacksmith in La Porte. The attached freight bill showed that the cost of the transportation from Stockholm to Marysville, California, by water equalled the wagon freight for the final 60 miles from Marysville to La Porte.

Wagon rates in 1865 varied from $1.60 to $9.00 per 100 pounds per 100 miles, or at the lowest figure $0.32 per ton-mile (that is, the cost of hauling one ton of 2,000 pounds one mile.) The average rail rate charged by the Central Pacific was far less and by 1882 had dropped to $0.0181 per ton mile. Passenger rates dropped in proportion, and rapidly reached a level which allowed immigrants to transport themselves and their possessions by the railroad to Western locations for settlement.

In his last report as General of the Army in 1883, the always quotable, William T. Sherman remarked:

I regard the building of these railways as the most important event of modern times, and believe they account fully for the peace and good order which

40. George Clark, *Leland Stanford* (Palo Alto: Stanford University Press, 1931) p. 3.

41. G. S. Lansing, *Relations between the Central Pacific Railroad Company and the United States Government* (San Francisco: H. S. Crocker & Company, 1889) p.49. Quoting from a report of the Pacific Railway Committee of the Senate dated February 19, 1869, 40th Congress, 3rd session.

now prevails in this land. A vast domain, equal to two-thirds of the whole surface of the United States, has been made accessible to the immigrant; and, in a military sense, our troops may be assembled at strategic points and sent promptly to places of disturbance, checking disorders in the bud. [42]

THE PROBLEM OF LOCAL TIME

The completion of the Pacific Railroad brought to the attention of the United States the need for a solution to a very different problem--the way the nation, (and ultimately, the world) kept *time*. The problem became apparent in the United States with the advent of railroading and with the transcontinental telegraph. Early railroads tended to operate along the Eastern Seaboard and probably kept the time of their main terminals, but by the beginning of the Civil War, they had reached a 1,000 miles (and over one hour in time difference) to the West.

Newspaper reporter George Parker sent a letter dated May 10, 1869 from Promontory to the *Sacramento Bee* which was published on the front page as coming "from the front" (the Civil War had ended only four years earlier and he seemed to consider railroad building like a military campaign). Parker wrote: "The trains on the Central Pacific run only on Sacramento time, which is telegraphed to the various stations from solar observations made by the time keeper."

At any location in the Northern Hemisphere the sun is due south of the observer and at its highest point exactly at noon on purely local time. This instant can be determined with relatively unsophisticated instruments, even the astrolabe of Columbus, and can be rechecked on any sunny day. It was therefore easy for each city to set and keep its own local time.[43]

With the sun moving westward at about 900 miles an hour (actually 814 mph at the latitude of Sacramento) and, before the railroad, the fastest communication being by a galloping horse--say 10 miles an hour--local time differences were, to coin a phrase, of small moment. The east-west telegraph changed all this and shortly after the transcontinental lines reached California, the editor of the La Porte *Mountain Messenger* (March 1, 1862, page 2, col.3) wrote:

> DIFFERENCE IN TIME.-When it is 12 o'clock M at, San Francisco, it is 14 minutes past 3, at New York, 25 minutes 48 seconds past 3 at Boston, 19 minutes 44 seconds past 2 at Chicago, 50 minutes and 40 seconds past 2 at Charleston, 9 minutes and 40 seconds past 2 at New Orleans, 9 minutes and 4 seconds past 2 at St. Louis and 41 minutes and 40 seconds past 1 at Salt Lake. These facts and figures are worth remembering in these days of telegraphic communication.
>
> The death of a man in New York a few days since, which occurred in the afternoon was announced in San Francisco by telegraph before 12 o'clock, M the same day.

While receiving news of events before they happened was an interesting novelty, in the matter of operating trains in opposite directions on single track railroads, ambiguities in the time being kept could be *deadly*. Various solutions to the problem were suggested and in 1869 Charles F. Dowd, a school principal in Saratoga, New York, proposed the use of time zones within which every location would use the same time. The work of an international conference in 1884 led to the adoption of 24 such time zones, each nominally having a width of 15 degrees of longitude. The difference in time between adjoining zones was set at exactly one hour, and at any instant the minutes and seconds would be the same around the earth (See also note 3, Appendix G, page 212).

PHOTOGRAPHING AT PROMONTORY

42. G. L. Lansing, *Relations between the Central Paciëc Railroad Company and the United States Government,* 1889 p. 47.

43. This observation yields an accurate measure of the instant of noon in Local Apparent Solar Time. In a discussion of this matter on January 30, 1995, Dr. Donald Hall of the Physics and Astronomy Department of California State University, Sacramento pointed out that due to variations in the apparent solar motion, the time from one such noon to the next one is not always 24 hours. These noon-to-noon variations can amount to a minute or more and may explain the necessity of telegraphing the correct time along the railroad on a daily basis despite trainmen's watches which were far more accurate than a minute-a-day rate of change.

Averaged over a year the noon-to-noon times will equal 24 hours within a small fraction of a second. For modern purposes, Local Mean Solar Time based on the average is more frequently employed.

Alfred A. Hart was on the train that brought the Stanford party from Sacramento to Promontory, and took a number of historic stereo views commemorating the ceremonies.[44] Moments after the Gold Spike was driven, the UP and CPRR locomotive engineers moved their locomotives together until the pilots (cowcatchers)

touched over the last spike. They then handed each other wine bottles, said by some to have contained Atlantic and Pacific water, while standing on the fronts of their locomotives.[45] Andrew Russell's record of this joyous occasion is probably the most famous photograph ever taken of an event in the nineteenth century. At about the same moment, Hart set up his camera on the other side of the track where in deference to the temperance views of the CPRR management the bottles were withdrawn, giving another reason to believe they probably were not filled with seawater.

Hart carefully followed his usual custom of including both the locomotive and tender of each train. Although the pilots of the locomotives were actually touching each other, this still required two separate stereographs. If Hart had moved the camera back enough to include both tenders, the image on the negative would have been too small and details of the people lost. Russell's genius lay in realizing that the pilots and smokestacks outlined the dramatic scene and that it took little imagination to envision the cab and tenders of the attached locomotives.

Hart called his stereo views "Monarch of the West" and "Monarch of the East" (Nos. 358 and 359). Despite the impressive titles, his resulting images are only a useful record of the day and the lavishly entertained Army Band. In Fig. 24 Hart's two views (probably taken within seconds of each other) have been combined for the first time to yield a scene somewhat comparable to Russell's, but with a more relaxed California feeling. The Army Band also appeared to have been really hitting the "seawater."

The railroad had been completed seven years before the required date, and at a huge celebration in Chicago, United States Vice President Schuyler Colfax, foresaw a future: "...Beyond the portrayal of language, beyond any words my heart could devise or that my tongue express to you upon this joyful night, the opening of the *new history of the American Republic.*" [Italics provided]

NOTES ON RAILROAD BOOKS AND APPENDIXES OF THIS BOOK

The full story of the building and use of the Central Pacific has occupied the efforts of many authors, starting with Alfred Hart's *The Traveler's Own Book* in 1870, and W. F. Rae's, *Westward by Rail: The New Route to the East,* in 1871. Hart's book also includes a folding map of the rail route from Chicago to San Francisco which provides miles, elevations, local agricultural products, and stagecoach connections along the way (See Appendix G). The text is both detailed and enthusiastic about the scenery, but strangely never mentions the years Hart spent along the CPRR or the fact that stereographs of the railroad made from his negatives were available for sale. He *does* however mention in the preface, that his book could be used as: "Auxiliary to the stereoscopic and other views which all travelers gather in their travels."

Four modern books, each containing a wealth of information and extensive bibliographies about the construction of the CPRR will be informative.[46]

44. The *San Francisco Chronicle,* May 11, 1869, p. 1 col.1, reported "A. A. Hart, artist of the Central Pacific, today took numerous sketches [photographs?] of the scenery around this Point [Promontory] and vicinity, which promises to afford complete views of this region." (Citation courtesy Pauline Spear).

45. In the photographs they look like ordinary wine and champagne bottles which were shown, in successive views, being handed in opposite directions. The UP train began its journey over 1,000 miles from the Atlantic Ocean and the CPRR 100 miles from the Pacific. Further, if they really contained seawater there would have been some show of pouring their contents on the rail junction, as salt water was of little other use in the Utah desert near the Great Salt Lake.

46. Wesley Griswold, *A Work of Giants* (1962), is very well researched and gives equal coverage to the stories of the formation and subsequent construction of both the Union Pacific and Central Pacific. Unfortunately, although Griswold listed over 275 publications in his bibliography and carefully recorded his archival source for each photograph, he appears not to have known that Alfred Hart ever existed.

George Kraus, *High Road to Promontory* (1969) covers only the Central Pacific, carefully credits Hart's work, and includes several excellent distance tables. Kraus was a headquarter's executive of the Southern Pacific Railroad (successor to the Central Pacific) and had access to many documents unavailable elsewhere.

This volume is specifically intended for librarians, collectors and researchers as an aid to identifying and understanding Hart's railroad photographs.
The next section deals with Hart as the CPRR photographer until 1870 and his activities in painting, publishing and inventing during the following 38 years until his death in 1908..
The following section gives details of the camera equipment and finishing processes used in his time.
Appendix A includes a reduced copy (3/7 scale) of every one of the 364 CPRR views published by Hart plus a number of variations. The titles in section A are not always those used by Hart, but are intended to give the present-day name of a location or explain some important detail. Hart's exact titles are used in Appendix B.
Appendix B which provides a numerical list of Hart's 364 known CPRR titles with many footnotes.
Appendix C is a geographic listing of the 364 CPRR titles arranged by miles from Sacramento so that all the titles near a given location will be found together. With these lists a researcher can obtain a desired image without looking at *every* view in a Hart collection. Appendix D provides a list of available public sources for most Hart railroad stereos.
Appendix E consists of a reprint of Glenn G. Willumson's well researched 1988 article on Hart's life published in *History of Photography* Magazine.[47] This essay provides more biographical information than anything else available on this subject.

ohn Hoyt Williams, *A Great and Shining Road* (New York & Toronto: Random House, 1988) contains many details not covered by Kraus or Griswold. Williams states that redwoods grew along the route of the CPRR, the Summit Tunnel sloped up and down and curved, and gives an incorrect formula for nitro-glycerin. Despite many such minor errors, the book is exciting to read and highly quotable. He includes several Hart photographs but fails to credit any photographers for the illustrations.

As the reader may have observed, this introduction covers only the construction of the CPRR and not its subsequent operation. Included are complimentary quotations and an obvious respect for the builders of the CPRR. In their lifetimes, and certainly later, there were numerous critics who held contrary opinions. For more information of this nature, particularly after 1869, the reader is referred to a recent book, Professor William Deverell, *Railroad Crossing* (London & Berkeley: University of California Press, 1994), pp. 1 - 5, 11 - 25 cover the time of the construction of the CPRR. The remainder of this most interesting volume, which includes an extensive bibliography and 61 pages of end notes, are devoted to the later operations of the CPRR and the Southern Pacific Co. and the social and economic problems resulting therefrom. The personal characters of the CPRR directors are also examined in detail.

47. Glenn Willumson, *Alfred Hart: Photographer of the Central Paciëc Railroad*-- *History of Photography*, (January/March 1988), pp. 61--75. The entire article is reprinted here (in Appendix E) by kind permission of the publisher. In a few instances opinions regarding the CPRR photographs expressed by the author, Glen Willumson, differ from those in the present notes. However a great many new facts have emerged since he wrote the article, and his opinions were carefully formed with the information then available.

Appendix F covers some details of the optics of stereo cameras, negative formats of Hart's day, and notes on a nineteenth century dark tent.
Appendix G features a reproduction of the CPRR portion of the map from Hart's 1870 pamphlet *The Traveler's Own Book*, and a few pages of text to indicate his literary style.

(Fig.23) Hart No. 356 *The Last Rail is Laid*. Taken from pilot of the CPRR locomotive JUPITER. Leland Stanford holds a hammer at the center. The stick in the foreground may have been a track gauge to ensure the proper separation of the rails.

(Fig. 24) Composite of Hart Nos. 359 & 358 *The Monarch from the East* (at left) and (at right) *The Monarch from the West*. The same man was at the front of the UPRR locomotive in both views and the hills behind indicate the trains did not move between exposures. (See p. 45)

RIGHT: (Fig. 25) Alfred Hart: No. 333 *Curving Iron, Ten Mile Canyon*. Rails were often bent to the proper curvature using sledge hammers and crowbars after they were spiked to the ties. However in this view the large supply of rails and the track car at the left suggest this crew may have been bending the rails to a template and sending them forward a short distance to the track layers.

NEXT PAGE: (Fig. 26) Alfred Hart: No. 357 *The Rival Monarchs*. Taken from the cab roof of UPRR locomotive No. 119, Captain Currier proudly stands before his troops, possibly to be photographed by the camera on the high tripod at the left of the locomotive JUPITER in the distance. (Fig. 24) was taken from the rise at the right.

(Fig. 28) Portion of Augustus Koch's Bird'seye View of Sacramento. Small arrows indicate Alfred Hart's locations at 135 J Street and later at 65 J Street. Sutter Lake is to the north, and Front or First Street is at the lower left. In Hart's day, Sacramento street numbers ran continuously from Front Street eastward with 32 numbers on each 320 foot block. Odd numbers were on the north side of the street; thus 135 J Street was on the north side of J, in the middle of the block between 5th and 6th; and 65 J was at the northeast corner of 3rd and J--a postman's nightmare! (View drawn in 1869)

ALFRED HART: PHOTOGRAPHER, AUTHOR AND PUBLISHER

Alfred A. Hart has been an elusive and shadowy figure until rather recent times. In 1918, ten years after Hart's death, Charles B. Turrill mentioned him in connection with his study of photographer Carleton E. Watkins. In 1969, George Kraus devoted half a page of the forward to his book, *High Road to Promontory,* to the historical importance of Hart's photographs and lamented the lack of recognition he had received.

In 1969, *American West* magazine published a seven- page article[48] on Hart's stereographs based on Kraus's book. Hart was not mentioned again in a publication until 1975 when Weston J. Naef and James N. Wood did so in their book *Era of Exploration: the Rise of Landscape Photography in the American West, 1860-1885,* (Boston: New Graphic Society, 1975) p. 45. Finally in 1976, a trained researcher became focussed on Hart as an individual rather than a little understood artist and photographer who took great pictures that others valued. Pauline Grenbeaux Spear was seeking material on Carleton Watkins at the Bancroft Library in Berkeley, where she saw a letter from Hart's great-grandson, John L. J. Hart then residing in Denver. John Hart was doing genealogical research and had inquired if the Bancroft Library had more information about Alfred A. Hart.

Ms. Spear, realizing the importance of this link with the past, contacted John Hart and arranged to interview him. He most graciously provided her with copies of material he had collected, and the names of other surviving family members. She followed these leads and soon began planning the publication of a fully researched book on Alfred Hart's life and work.[49] However in 1978 her own career goals shifted, and it became apparent that it would be many years before the book's completion. In the same generous spirit, demonstrated by John Hart in sharing his research with her, she advised Dr. Joseph Baird, her former professor of art history at the University of California at Davis, that she had a possible subject for a thesis and a great deal of research available for the right graduate student.

Dr. Baird reviewed the qualifications of several of his students

48. ---- *The Muscle, The Gold, and the Iron--Documenting the Construction of the Central Paciёc--The Stereographs of Alfred A. Hart.* American West, May 1969, pp. 13--19. There are many illustrations in this article of Hart's railroad views and of stereo equipment belonging to the Oakland Museum. Unfortunately the stereo camera shown is a later model than Hart would have used and has pneumatic shutters and a tilting front, not available in Hart's CPRR time.

49. In Peter Palmquist's article, *Alfred Hart and the Illustrated Traveler's Map of the Central Paciёc Railroad,* STEREO WORLD (January-February 1980), he says in endnote 6: "Hopefully, research presently being conducted by photo-historian Pauline Grenbeaux will eventually solve many of the mysteries which surround Hart's life and works."

and suggested the name of Glenn Willumson, to whom she turned over the results of all her research on Alfred A. Hart. Mr. Willumson carried the project forward, completing his thesis in 1982. In 1988 he also published an article on Hart's life (See Appendix E). The information in the following pages about Hart's non railroad activities has been gleaned from Willumson's excellent article.

(Fig. 29) Portion of Thomas Houseworth No. 1204 *Sacramento--J Street from Sixth Street*. Hart's 135 J Street location was in the building just to the right of the post and across the street from the camera position. He was next door to (on the far side of) McDonald's Drug Store which was at 139 J Street.

Alfred A. Hart was born March 28, 1816, in Norwich, Connecticut, and received his first training as a fine arts painter, later making his living as a portrait painter for a number of years in nearby Hartford. In 1852, he painted a long panorama portaying Biblical scenes the Holy Land on a roll of canvas. In New York, the panorama was unrolled from one vertical spool to another
at the opposite side of a stage, pausing while "Professor" Hart lectured about the scene depicted (See p. 191). Five years later Hart was back in Hartford as a partner in a daguerreotype studio, and in the early 1860s he moved his family to Cleveland, Ohio, where he operated an art store. Although the reasons for his next move are not clear, by 1863 he had left his family in Cleveland with the store and was taking photographs in California. In 1864 the *Cleveland City Directory* indicated his store was offering "photographic stock," which could be interpreted as meaning he had returned with a supply of California photographs to sell. Hart was already 46 years old and an experienced photographer and artist at the time the Central Pacific Railroad commenced construction in Sacramento on January 8, 1863. There is no evidence of Hart's presence at the
ceremony, although we know from a surviving newspaper advertisement that he was in La Porte, California, during June/July 1863 and would normally have traveled there by way of Sacramento. At that time, La Porte was an isolated and rather small town in Sierra County, and it seems likely that Hart had been in California for at least a few months before deciding that this particular village was in need of a photographer.

On June 13, 1863, Hart placed an advertisement for his "La Porte Photographic Gallery" in the weekly La Porte *Mountain Messenger,* (published on Saturdays) and continued it through the issue of July 18, 1863 (Fig. 30). In the June 20th issue there was also an editorial comment:

PICTURES OF LIFE -- Alfred Hart has opened a Photographic Studio on Main Street, La Porte, and is taking excellent LIKENESSES. Those visiting our town on the day of the Masonic celebration will have a fine opportunity of getting good pictures.

Coincidentally, there also appeared an advertisement (Fig. 31) for the optical firm of Lawrence & Houseworth, offering stereoscopic equipment for sale.[50] La Porte was not the "Paris" of Sierra County (in fact Sierra County gave La Porte to Plumas County later in 1864), and for a non-recreational drinker the evenings allowed more than ample time for reading. Perhaps it was there on a Saturday that Hart saw Lawrence & Houseworth's advertisement near his own, realized the potential opportunity, and decided to contact them.

(Fig. 30) Hart's advertisement in the La Porte *Mountain Messenger*.

(Fig. 31) Advertisement in the *Mountain Messenger*.

They became the first to publish Hart's CPRR stereo photographs (Nos.134 to 148) and regularly purchased other

50. Later Lawrence & Houseworth changed this advertisement in the *Mountain Messenger* to that shown in (Fig. 35) and addressed it to photographers from whom they offered to buy prints or negatives. By that time, the newspaper had moved to Downieville, (Sierra County) where it remains to this day (1995) as the oldest weekly newspaper in California.

CPRR negatives from him as construction progressed. While we do not know of any photographs of Yuba or Sierra Counties specifically taken or published by Hart, Lawrence & Houseworth published many early Yuba County hydraulic mining stereographs which *may well* have been taken by Alfred A. Hart.

These hydraulic mining stereos, like the Hart CPRR Nos. 134 through 148 in Appendix A, were first published by Lawrence & Houseworth without numbers, were copyrighted in 1865, and are quite similar in photographic style to the CPRR views.[51] Other evidence also supports this idea: Hart was familiar with this hydraulic mining area, and took (and later published) stereo photographs of mining 18 miles away. Also the main wagon road in 1863/64 to La Porte was from Marysville and passed directly through Yuba County, only a few miles north west of some of the mining areas depicted in Lawrence & Houseworth's stereographs.[52]
It seems probable that Hart initially planned to publish his own mining negatives commercially as he had already gone to the expense of having stereo card mounts printed with "Hydraulic Mining" on the front, and "Scenes in the Sierra Nevada Mountains for the Stereoscope and Album. Alfred A. Hart, Artist, Sacramento." on the verso, (See Appendix A, No. 167). This would further support the theory that Hart actually took the hydraulic mining stereo photographs published by Lawrence & Houseworth and copyrighted in 1865. Hart had either held back a few of the negatives, or expected to regain their use as later happened with the CPRR stereo negatives.

Hart probably took many other non-CPRR stereos published by Lawrence & Houseworth in 1864-66. For example, Hart published (without title or number) a summer stereo view that Lawrence & Houseworth published as No. 816 "Grass Valley from Cemetery Hill, Nevada Co." Such photographic assignments could easily have occupied Hart throughout the summer of 1864. "Summer" is suggested because of the heavy foliage on the trees at Grass Valley and the ample supplies of water shown in the hydraulic mining scenes. The mining ditches filled as the snow melted in the mountains, and usually dried up by July or August.[53]

DATING HART'S RAILROAD CONSTRUCTION STEREOS

Because railroad construction advanced predictably along a known route, and the precise dates when the tracks reached certain locations are known, it is possible to state that a photograph showing track in place was taken *after* a certain date. Some 30 well-identified checkpoints are known for the early progress, but dating photographs made on later trips requires additional information. The season of the year in some instances is indicated by flowering fruit trees in spring or the lushness of the tall, deciduous Valley Oaks.

51. Peter Palmquist, *Lawrence & Houseworth/ Thomas Houseworth & Co.* (Columbus, Ohio: National Stereoscopic Association, 1980), p. 65, Citation courtesy of Barry Swackhamer. The unnumbered mining set and some of the Hart CPRR stereos were later assigned adjacent number series in Lawrence & Houseworth's 1865 catalog, the mining images were listed Nos. 790 -- 809 and the CPRR stereos Nos. 815 -- 822.
52. In 1863/64 access to La Porte from the south (Downieville), east (Quincy), and north involved travelling on horse back by "passenger train" (or in later years "saddle train"), and in the four months of snow, on skis (then called "snow-shoes").
53. Another Hart-published stereo is imprinted "Hydraulic Mining" on the front of the card mount and uses the same back printing mentioned in the text. The scene is the Eureka Claim, North San Juan (18 miles NE of Timbuctoo where many of the L&H mining scenes were located). When Carleton E. Watkins published Hart's CPRR negatives, he substituted a closer Hart view of the North San Juan site for Hart's original No. 61 at Gold Run (See Appendix A, No. 61(a). At the extreme bottom of the Society of California Pioneers print of Watkins' No. 61 can be seen in black "nauJ naS htorN mialC akeruE" (the letters are also reversed) suggesting the words had been scratched through the emulsion of the negative outside the area expected to be printed.

(Fig. 32) CPRR Locomotive No. 1, the GOV. STANFORD next to the railroad docks at the foot of I Street in Sacramento. The building at the right houses the city hall, jail, and waterworks. The man in the white coat on the pile of rails may be Chief Engineer Sam Montague.

PAGE TO LEFT: (Fig. 33) Hart No. 135, *Locomotive on Trestle*. Taken March 16, 1865, three miles from Sacramento on the trestle leaving the American River Bridge. The supports are 12 x 12 timbers on 12-foot spacing (See p. 59).

ABOVE: (Fig. 34) Alfred Hart: Untitled. Railroad town, probably Truckee. A team of oxen are at the right, and (in the original) one can see men lined up to enter "Railroad Chop House" and a sign for a boot maker. As in all the railroad scenes there are no fat men--the only even "heavy" one being Judge Crocker in a few scenes below Auburn. Back imprint is Q in Appendix. A.

RIGHT: (Fig. 35) Lawrence & Houseworth's offer to purchase stereo negatives in the Downieville *Mountain Messenger* of May 7, 1864.

AN EXAMPLE OF HART TAKING A VIEW FOR HIMSELF AND A SIMILAR ONE FOR THOMAS HOUSEWORTH

(Fig. 36) Thomas Houseworth No. 1213. Enlarged right image of a stereograph taken from the State Capitol to the northwest. The shadows and the season would suggest it was taken about 2 p.m. In taking this scene a few minutes before (Fig. 37) the photographer, Hart?? has moved forward to the edge of the dome base and turned his camera a bit to the left. The broken stones on the ground are in identical positions, but the person pushing the small cart to the left on 10th street in Hart's view has not yet appeared.

(Fig. 37) Alfred Hart: Enlarged right image of an untitled stereograph he published on a card with "Valley of the Sacramento, 135 J Street" back imprint. Taken in the winter of 1867/68 from the base of the dome of the California State Capitol while it was under construction. The view is to the northwest over the intersection of 10th and L Streets and the close bricks give a strong stereo effect. A person pushing a small white cart is just visible at the right on the far side of 10th street.

However, constructing the railroad involved removing *all* trees along the right-of-way, and because the constant need for firewood caused the cutting of many more, distant trees must generally be relied on for determining the season in Hart's early railroad photographs.

Some dating is aided by a knowledge of traits peculiar to wet-plate photography, for instance, at lower elevations the highly blue/green sensitivity of Hart's plates tend to make the leaves of the evergreen Live Oak look white and dead even in summer. Unfortunately, trees are of little use in determining the season in the high mountains because 95 percent of them are evergreens and look the same all year.

Occasional news accounts of the delivery of the locomotives and regular construction progress reports provide additional help, but the usual detective work is still required. The task of determining the publication dates of Hart's stereographs often depends primarily on circumstantial evidence and an unfortunately large amount of conjecture. Hart himself left only minimal information as to his working locations in California prior to 1866, consequently the following summary will only outline what is available today.

After La Porte, the next certain date for Hart's location is based on his No. 135 of the large locomotive CONNESS, on its maiden trip,on one of the approaches to the American River Bridge taken March 16, 1865, as reported in the *Sacramento Union* the next day. This was probably the only such excursion of the CONNESS because it was particularly wasteful to send a locomotive of this size up the line without any cars and most unusual to have it loaded so heavily with such well-dressed passengers (imagine the insurance premium for such a trip today).

A similar locomotive, headed away from the camera and with its tender loaded the same way as the CONNESS, can be seen with a magnifier, at the far end of the American River Bridge (Fig. 5.) In this same scene, Judge E. B. Crocker stands looking at the small locomotive HUNTINGTON in the foreground. The Valley Oaks seen in the distance are without leaves, substantiating a March date. Taken shortly thereafter is Hart's No. 139 of the locomotive CONNESS barely squeezed onto a turntable at Newcastle, California. The presence of the CONNESS and the unfinished trestle confirms a date after March 16, 1865, and before the track layers worked eastward from Newcastle in late April to reach Auburn (4 miles away) on May 13th. At Newcastle's 900-foot elevation, the Oaks are already leafing out by April, and many in this view are bare: so a close guess would date the photograph in late March 1865.
As mentioned earlier, the negative for this and a number of other Hart stereos (No. 135 through No. 148) were first sold by Hart to Lawrence & Houseworth who published them, with titles, but frequently without series numbers. Later Hart regained control of these negatives and incorporated them in his own series.[54] The Lawrence & Houseworth versions are not common, but are still seen more frequently than those published by Hart.
Although he continued to take stereo negatives for Lawrence & Houseworth, sometime in 1865, Hart became the official photographer of the CPRR, possibly through the influence of his friend and CPRR director, Judge E. B. Crocker. Between June 10, 1865, when the rails reached Clipper Gap and late December 1865, Hart completed a series of 32 stereo negatives picturing the progress of the CPRR between Newcastle and just above Clipper Gap.
He submitted the bill for these (in the amount of $150.00) in late December and was paid by the CPRR on January 2, 1866. The negatives were then forwarded to Huntington in New York, who arranged to have them printed and mounted by the firm of Whitney & Paradise. These stereo cards were identified by back labels giving the image number and description followed by the statement: "Negatives by A.A. Hart".[55] Most of these stereographs (Numbers 1 through 32 in appendix A) are generally unexciting overviews of distant trestles and cuts with the track in place, above Newcastle. Although some of the Whitney & Paradise stereographs were sold to the public, they were probably also used by Huntington in New York to share with potential bond buyers.
These negatives were eventually returned to Hart's control, although the date of their return is not certain, and he began publishing them himself using Whitney & Paradise numbers, but sometimes altering the title. For example Whitney & Paradise called No. 3, "Newcastle and R.R. from the East," while Hart published it as, "Depot and Trestle, at Newcastle." The sale dates of the Whitney & Paradise stereographs is further evidenced by the tax stamps affixed to the back of the mounts.

DATING STEREOS WITH TAX STAMPS

Between September 1, 1864 and August 1, 1866, as a Civil War measure, paper "luxuries" like bank checks, photographs and invoices were required to have a revenue stamp affixed at the time of sale or use. The user or retailer was further required to cancel this stamp by handwriting in ink or with a rubber stamp impression.
For photographs, the denominations to be used were:

Retail Sale Price	Denomination of Tax Stamp
25¢ or less	2 ¢
26¢ to 50¢	3 ¢
51¢ to $1.00	4 ¢

54. His original negatives may never have left his studio. As described on page 81, under "Printing the Negatives," a single negative required over an hour exposure to sunlight (and usually longer). For quantity production, copy negatives were essential, and Hart may have supplied a set of these to Lawrence & Houseworth, and as mentioned on p. 60 , Whitney & Paradise.

55. It was very unusual for a stereo publisher to include the name of the actual photographer, usually claiming that honor for themselves with the phrase "Photographed and Published by..."

The correct stamps for photographs said "Proprietary" at the bottom. At least three of the early Whitney & Paradise views were sold for less than 26 cents before August 1, 1866, as they have an orange two-cent internal revenue "bank check" stamp on the back. The use of bank check rather than proprietary stamps can be explained by the fact that by the summer of 1866 it was known the tax would end soon. Nobody wanted to buy stamps to pay for a war that had already been won--one can also imagine how popular they were in the former Confederacy! Thus, in the last months before August 1, 1866, the government allowed the use of other types of documentary stamps and even ordinary postage stamps. From these data, it may be deduced that the three Whitney & Paradise cards were sold in the summer of 1866 at a time when they were using up their stock of bank check stamps.

Many of the earliest Hart CPRR stereographs, published by Lawrence & Houseworth without catalog numbers have green three-cent "Proprietary" stamps on the back and, on the front a copyright notice dated 1865. The required cancellation was accomplished with a round rubber stamp by someone who was seemingly careful to avoid placing the cancellation mark directly on the image of Washington's face. This consistent method, together with the fact that parts of the word "Houseworth" appear, would indicate they were sold at retail for 50-cents or less by the firm and not wholesaled to others, who would have used their own cancellation methods.[56]

Because of the absence of revenue stamps and the fact that the majority of his views depict scenes that occurred after September 1, 1864, Hart must have started publishing, or at least selling views on his own stereo cards at some point after August 1866. (If Hart sold cards before September 1, 1864, he also wouldn't have needed to affix tax stamps.) Other evidence suggests a sale date at least a year later. It also seems reasonable that Hart would not go to the expense of having a stock of labels and card mounts printed until a commercial volume of views had been taken, and the return to his control of the Whitney & Paradise and Houseworth CPRR negatives would be an added incentive to commence self-publishing. That would help explain the insertion of the previously unnumbered Hart/Houseworth negatives at Nos. 135 to 148 and maintaining the previously low numbered Hart/Whitney & Paradise views at the start of the series.

If these suppositions are correct--and since no view before No. 135 shows a scene that can be definitely dated after November 30, 1867, when the Summit Tunnel was completed--it's highly possible that Hart began publishing stereographs in the winter of 1866/67. As further support, the Grizzly Hill Tunnel (No. 1) was completed August 27, 1866, and Hart No. 89 pictures it finished without rails. Hart No. 78 shows rails at Green Bluffs, six miles to the west which was reached on approximately August 15, 1866. Further, view No. 118 is of the eastern end of the Summit Tunnel (tunnel #6) before the huge fill between it and tunnel #7 had been made, again suggesting late fall of 1866. Hart could very well have started publishing at a later date, but the insertion in the series of the block of CPRR negatives used earlier by Lawrence & Houseworth again suggests an 1866 date. The scenes pictured on the stereographs just *before* the inserted series (Nos. 134-148) show areas around the summit taken well before the tunnels were finished in 1867. The negatives for the stereographs just *after* the inserted series were taken of the finished track between Colfax and Grizzly Hill Tunnel completed August 27, 1866.

If the negatives first used by Lawrence & Houseworth had

56. Unfortunately, modern researchers working in the 1864/66 time-frame frequently see valuable material damaged by having had these stamps soaked off or cut out of the document being studied. (The stamps are almost worthless compared to the material from which they have been removed.) In the words of Bruce Carson of Classic Stamps and Covers, a stamp dealer in Sacramento, on February 2, 1994: "The two and three cent ones are worth around twenty-five cents and the four cent denomination might go for a dollar." The required cancellation of the revenue stamps was occasionally done by writing the date of sale across them.

been returned in 1866 as suggested, when Hart had completed and numbered 133 views, it would have been logical and convenient for him to place the lot at the end of the series already completed and number them accordingly. Inserting each negative at the proper distance from Sacramento would have required renumbering all those being further from Sacramento (and thus having higher numbers).

Hart took great pains to arrange most of the first 133 negatives by distance from Sacramento--for example, No. 8 shows the west end of Bloomer Cut, and No. 9 is 200 yards further in the cut; No. 132 shows the north side of Donner Lake, and No. 133 the Donner Camp about a mile further east. This would suggest that Hart, like some of us today, accumulated a large number of negatives and then organized and numbered the entire set. Still his Nos. 56-60 are out of order, as are Nos. 73-78, where he jumped back to pick up views further to the west.

Sometimes additional information can be obtained when a Hart stereograph is found with a specific date and the name of the buyer written on the back. Presumably the date written would be the time of purchase, although in an isolated case it might refer to the time the place depicted was visited.

Two collections yielded ten such Hart cards (Nos. 3, 43, 90, 100, 132, 163, 171, 181, 195, and 203) with the name of "J. W. Allyne, August 1868" in a contemporary hand on the reverse. Nine of these show (printed on the reverse) "ALFRED A. HART, Artist, 135 J Street, Sacramento," probably indicating Hart was publishing from that address *before* August 1868. No "Allyne" card depicts a construction scene finished after the summer of 1867, which would tend to support August 1868 as the purchase date rather than the date of a visit.

Unfortunately the Sacramento City Directories for 1866, 1868, and 1869 (no directory was published in 1867) list neither Alfred A. Hart nor his place of business. On the other hand, imprints on the back of his published stereo cards show either 135 J Street, 65 J Street, Sacramento, or no address. It is very probable that 65 J Street was his last location in Sacramento, as his immediate successor, Frank Durgan, (See Appendix A, backs F & G) also used that address, and Hart's views of the 1869 portions of the CPRR construction list the same location on the reverse.

The office at 65 J was in a large edifice occupied by professional tenants, while 135 J was a small building with Sam Levy's clothing store on the ground floor--hardly suitable for Hart's *Golden State Photographic Gallery*.

(For the earliest dates possible where tracks are shown in a Hart view, the following list may prove helpful.)

Barry Swackhamer, who is an astute researcher of the Hart stereo cards and their variations, has gleaned additional supporting information. He has observed that while the 65 J Street address can be found on almost any of the 364 views, he has not found any cards with a 135 J Street address showing CPRR construction later than No. 338 of the Palisades

where rails arrived in January 1869.
Since the card mounts were rather expensive, Hart could well have had a stock of the old ones and used them *after* the change to 65 J Street.[57] Offsetting this presumed chronology would be any natural delay in developing and printing the images and preparing the title strips. The sum total of the data suggests that Hart could have moved in late 1868 or early 1869. Additional support for 135 J Street as the earlier location is given by the J.W. Allyne notations mentioned above.
A portion of an 1870 bird'seye view of Sacramento's J Street showing both Hart's 135 and 65 J Street locations is included in Fig. 28.[58] Hart's move to the more expensive location at 65 J Street could well have been in anticipation of the new business he expected in publishing his railroad stereographs and the *Photographic Railroad Advertiser*.
Glenn Willumson has proposed the possibility that all 364 of the Hart CPRR railroad stereos were taken on a relatively small number of expeditions, perhaps as few as five.

He tentatively proposed that these trips consist of the following chronological sets:

Nos. 1 to 133	1865 or 1866
Nos. 134 to 148	1864 or 1865
Nos. 149 to 239	1867
Nos. 240 to 342	1868
Nos. 343 to 364	May 1869

The general principle Willumson suggested is certainly sound and represents a lot of serious study. However by studying the different locomotives and rail cars appearing in the photographs, checking the time required to reach some of the camera sites and estimating the time of day from shadows, it appears the total number of different excursions was more likely ten and possibly as many as 20. Willumson has provided a logical grouping, but unfortunately, without information from sources other than the photographs themselves, it is extremely difficult to determine the locations photographed on a given excursion up the railroad. Much of the difficulty stems from Hart's basic system of assigning view numbers by distance from Sacramento rather than chronologically. The photographs taken at Promontory illustrate this point very well (See Appendix B, footnotes 142 and 144 on p. 166).[59]

57. Hart published stereographs with many different styles of printed backs. Twenty-six different examples are illustrated at the end of Appendix A.
58. It may be just a coincidence, but almost every photographer listed in the Sacramento City Directories was located on the north (odd numbered) side of a lettered street--usually J. This meant north-facing windows were in the back or cheaper part of the buildings. Perhaps a reader has a more logical answer.

59. As an aside, it seems that in the 1970-90s as in Hart's day, more pictures are taken on the way *into* the mountains from Sacramento than on the return. One has a tendency to push on as far as daylight, the photographer's strength, (and in Hart's case, the train crew) permit, necessitating a rush home in failing light. The majority of Hart's trains and locomotives are pictured going east, and occasionally without a headlight on the locomotive, perhaps a subtle message from the trainmen that they must be back in Sacramento before dark.

(Fig. 38) Alfred Hart: No.163 *Frame for Snow Covering, interior view.* Probably taken very near Emigrant Gap, California, as No. 162 in the series is a few miles below Emigrant Gap and No. 164 is there. If viewed in stereo (impossible with this illustration because of the 140 percent enlargement) this scene gives a tremendous feeling of depth. In the extreme distance one can see the last car of the same train appearing in Nos. 153, 156, 158, and 165. The snowshed pictured was of rather light construction compared to those at Donner Summit built to resist avalanches. At the 5,200 foot elevation of Emigrant Gap snow over 4 feet deep is very rare, and there were no overhanging cliffs. The roof and sides of the frame had not been covered, resulting in the interesting interplay of light and shadow.

(Fig. 39) Portion of Hart No. 225 showing shadow of Hart, his camera, and dark-cloth. The camera shadow is clear, but Hart's is fuzzy indicating he may have moved to uncap and recap the lenses during the exposure. (This bridge is on the Truckee River west of Reno.)

(Fig. 40) Portion of Hart No. 167 *Emigrant Gap looking West*. Hart's black photo wagon is on the fourth flat car. In Nevada, he usually used a white wagon, and in some views, one can see he has unhitched the horse from the wagon to allow it to graze or drink from a nearby stream.

(Fig. 41) Alfred Hart: No. 323 *Shoshone Indians looking at Locomotive on the Desert*. Probably taken shortly after rails reached Winnemucca, on October 1,1868. This locomotive, named CHAMPION, appears to be a fast passenger type built by McKay & Aldus of Boston in late 1867. The headlight is unusual, and a coat (Hart's?) is under the right cowcatcher brace.

Throughout his working association with the Central Pacific, *Hart's mentor was Judge E. B. Crocker*. Payment for Hart's first invoice was approved by the Judge and he also selected and favorably commented on later Hart views.[60] Because of this influential connection and in his role as the official CPRR photographer, Hart had the power to halt trains at photo opportunities and even to stop and pose the rushing construction workers on the job. Unfortunately, Judge Crocker suffered a heart attack and retired from the Central Pacific board of directors in the latter part of 1869, and Hart's special connection with the railroad terminated within a few months. When in late 1869 Hart placed his advertisement in the upcoming 1870 Sacramento Directory (Fig. 19), he did not seem to realize that Carleton E. Watkins (a great photographer and close friend of CPRR Vice President, Collis Huntington) was already at work taking views in eastern Nevada and Utah for the railroad.[61] Careful research has produced no hard evidence that Hart ever took, or at least published, any photograph after 1870. There may be exceptions to this statement assuming the following conjectures are correct: within a few days following the Gold Spike ceremony, Sacramento newspapers noted that hundreds of construction wagons were being hauled in from Utah to be shipped down the river for use in speeding completion of the CPRR's Western Pacific (WPRR) branch into San Jose and San Francisco. This railroad is not to be confused with the much later Western Pacific built up the Feather River in 1910 under independent ownership and now a part of the Union Pacific.

Many of the top construction men Hart knew from the CPRR, including Strobridge, were working on this branch line. The railroad approached San Francisco by building south from Sacramento and passing through Stockton, Livermore pass, Altamont and Niles Canyon to a junction at Niles. At this point the route divided with one branch going south through Milpitas to San Jose and then north to San Francisco on the already completed San Francisco & San Jose RR (later the Southern Pacific). The other branch headed north through San Leandro to Alameda and a huge pier from which San Francisco was reached by passenger and rail car ferries.[62] In 1869 Thomas Houseworth, to whom Hart had sold railroad views of the CPRR for years, copyrighted at least one of a long series of

60. Glenn Willumson, Appendix E, end note 24.

61. "Mr. C. E. Watkins, the distinguished landscape photographer, is now engaged in taking views along the line of the Pacific Railroad...." *Illustrated San Francisco News*, August 14, 1869, p. 15, as cited by Peter Palmquist, *Carleton E. Watkins, Photographer of the American West*. (Albuquerque: University of New Mexico Press, 1983) p. 47, fn.141.

62. See first map in Appendix G which also provides California Bay Area city populations in 1870; for instance, San Mateo,s was 600, and San Leandro's, 1,000.

views of the Oakland branch.[63]
The similarities of many of these stereos with those taken by Hart on the CPRR are very noticeable. The dry vegetation, progress of construction, and coats worn by the few men depicted would indicate the date as early fall of 1869 when Hart was already finished with the CPRR, and available for a new assignment.
Hart also published, without a printed title strip, at least three interior views of Pullman Palace sleeping cars. In one of these, the door at the end of the car is open and a flatcar and seemingly a palm tree are just visible, suggesting a possible Oakland pier location. Two of these cards are imprinted "Central Pacific Railroad" and "California" on the front and Alfred A. Hart's "Golden State Photographic Gallery," on the back. In addition, one of them has a small label glued to the back reading:

CELEBRITIES for the ALBUM
E. LOVEJOY
110 Clark Street, Chicago

The other stereo card is unusual in that the front is imprinted "PULLMAN PALACE" at the left end and "SLEEPING CAR" at the right. The back imprint is also unique (The card's obverse is in Appendix A, No. 1000 and the back is C). As in the case of Hart's having printed "Hydraulic Mining" cards, he may well have intended to publish a series on passenger car interiors after selling a few trial negatives to Houseworth. The Houseworth car interiors are very similar to the Hart views in the angle of lens coverage and the careful inclusion of ceiling detail at the cost of overexposing the side windows.

63. Peter Palmquist, *Lawrence & Houseworth and Thomas Houseworth. A Unique View of the West 1860 - 1886.* (Columbus, Ohio: National Stereoscopic Association, 1980), p. 123. The series includes a number of images showing luxurious passenger car interiors. These may have been taken at Oakland since some exterior views of similar cars are included from that location. The Houseworth numbers are #1466 -- # 1568. The scenes shown on Houseworth cards published before 1870 are easy to date since the copyright date of the original negative is included on the right end of the front (recto) of the card. For example card No. 1510, with the copyright date of 1869, pictures a fall-of-the-year view of the WPRR tracks near Livermore with a tall man (Strobridge?) at the right.

These facts indicate a possibility that Alfred Hart's last photographic activities, before leaving Sacramento, were the development and printing of negatives taken in the fall and winter of 1869 for Thomas Houseworth & Co. An item of additional support for this theory has nothing to do with logic. Who else but Hart, the man who photographed Chinese drillers proudly showing their rock drilling technique at Donner Summit, a Piute Indian mother turning shyly to display her baby on her back at Reno, or James Strobridge standing at the scene of his triumph on the Utah desert *could* have taken "Decoy Sheep-Oakland Wharf?"
The view pictures a bearded gentleman affectionately resting his hand on a sheep that had been trained to lead other sheep on and off railroad cars. Admittedly the "training" may not yet have been complete as a long rope is attached to the decoy's collar, but the owner's pride is still evident, and the sheep also seems quite pleased with itself. [64] This is simply not a photograph planned by an editor, but instead was an on-the-spot decision by a photographer who understood what would interest the largely agrarian public of that day.

(Fig. 42) T. Houseworth: No. 1498 *Decoy Sheep--Oakland Wharf.*

THE FATE OF HART'S CPRR NEGATIVES

The events of late 1869 and the subsequent fate of Hart's railroad negatives deserve special review. In addition to the 32 negatives Hart sold to the CPRR in January 1866, it appears the railroad had also retained control of the remainder of his CPRR stereo negatives and was allowing others to print stereographs from them, notably the partnership of Eli S.

64. As the Urban reader may not realize, training a sheep to do *anything* is a not inconsiderable accomplishment. For their size, sheep may well be the slowest learning creatures in the animal kingdom. As a sheepherder once said: "It would be easier to teach a dog to play the banjo, than to teach a sheep to sit down." Goats, which are far more intelligent, were normally used to lead sheep into confined spaces; hence "Judas Goat."

Dennison and Frank Durgan who followed Hart in being given use of the negatives. Durgan assumed the role of "photographer" and continued to use Hart's old 65 J Street address (although this was a large building and he could have easily located in a different room). Dennison was identified as the sales agent and had previously been listed as a CPRR conductor in the 1869 directory (prepared in late 1868). He was also the conductor of Stanford's train to Promontory. The 1870 directory indicated that Dennison was news agent of the CPRR and the Western Pacific Railroad with offices at 3 Front Street. In the style then prevalent, Durgan proclaimed on the back of his cards that the Hart view on the other side was "Photographed and Published by Frank Durgan" (see Appendix A, backs F & G). Frank Durgan was not listed in the 1869 Sacramento directory and in the 1870 directory he was listed as "photographer, with J. A. Todd, 82 J Street." Neither Dennison nor Durgan was listed in the 1871 directory. In addition to these publishers, a few Hart stereo negatives appear printed on cards bearing the imprint of J. H. Heering of San Jose. John H. Heering is listed as a photographer on First Street in San Jose in Langley's *Paciëc Coast Business Directory for 1867* (San Francisco: Excelsior Steam Presses, 1867).

In one such view of Meadow Lake (Hart No. 180), a Hart label with the correct number and title has been pasted on the back, but the relationship between Hart and Heering remains unclear. By 1870 Carleton E. Watkins was at work publishing most of the Hart CPRR negatives, with Hart's original numbers and nearly identical titles, but without credit to Hart.[65] Watkins mounted the prints from the Hart negatives on cards identified as "Watkins' Pacific Railroad", "Central Pacific Railroad," "Watkins' Pacific Coast," and after 1876 "Watkins' New Series, Central and Union Pacific R.R's." This latter group also included photographs of the Union and Central Pacific Railroads actually taken by Watkins.

Watkins and C.P. Huntington (Vice President of the Central Pacific) were friends and had both lived in Oneonta, New York before coming to California. This may have influenced the transfer of the use of the negatives, although Watkins was already recognized as one of the best and most visible photographers in the West and had previously done work for the CPRR in 1869.[66]

65. With two exceptions, Watkins apparently failed to obtain any of the negatives for the early Hart series used by Lawrence & Houseworth and later numbered # 134 -- # 148. The prints from the Hart negatives used by Watkins at the Society of California Pioneers include from this group only Nos. 138 (The freight depot at Newcastle) and 145 (Building the Trestle at Newcastle). In checking five major collections, no CPRR stereo cards with the missing numbers could be found on Watkins' mounts. At least one of the missing negatives (No.135) was published by Frank Durgan indicating they were probably removed after Hart left Sacramento. They could also have escaped the 1906 San Francisco Earthquake and be in Lewiston, Maine as mentioned later.

66. For a detailed discussion of Watkins' work and many fine examples of his photographs; see Peter Palmquist, *Carleton E. Watkins, Photographer of the American West*. On page 26 Palmquist gives information about Watkins' own difficulty with people copying his work.

(Fig. 43) Hart No 217, Showing loading Wells Fargo stage coaches at Cisco Station in 1867. The passenger station and Wells Fargo office were in the upper part of town next to the main line. Until completion of the Summit Tunnels in 1868, stage coaches and freight wagons loaded here for Virginia City and the Comstock mines.

(Fig. 44) Same location in 1990. The tall tree obscures the left end of the flat-topped mountain visible in Hart's view. (MBK photo)

PAGE TO LEFT: (Fig. 47) August 1992 Looking east in reinforced concrete snowshed below Crested (now Donner) Peak. Compare with Hart No. 252 taken in 1868 at the same location. (MBK Photo)

The fact that Watkins retained the use of the Hart negatives after his 1876 bankruptcy further supports their ownership by the CPRR. As described by Charles B. Turrill: "...a sale was made of his [Watkins'] entire property at his studio, 26 Montgomery Street. At that sale the negatives and photographic equipment were purchased in the interest of I.W. Taber." [67] Had the Hart negatives belonged to Watkins, or even been on loan from another person, Taber, who was a very successful businessman, would probably have taken them as part of the purchase. But in California in 1875, no one would have dared to illegally take the property of the owners of the Central Pacific Railroad, known as the "Big Four."
Watkins continued to publish Hart's CPRR negatives after 1876, but by the time of their destruction in the 1906 San Francisco Earthquake, they were no longer being published as stereo cards. Glass lantern slides of some Hart views were still in the possession of the CPRR's successor, The Southern Pacific Company, as late as 1963, but they had obviously not been used for many years. We will probably never know the entire sequence of events surrounding the use of Hart's negatives.

67. Cited by Peter Palmquist in *Carleton E. Watkins, Photographer of the American West,* p. 52.

Sometimes an occasional Hart view turns up with a rubber stamp on the back reading: "From F. Durgan & Co. Opp. Wood's Block, Lisbon St. LEWISTON" [Maine]. Also from Lewiston, but with a different publisher, Barry Swackhamer found another interesting Lewiston stereograph

of Hart's labelled No. 130. We know that Watkins used the same title and number, but since he used a different scene there exists the possibility the original negative had already been removed before he assumed control of the negatives in 1870. The reverse of this view reads: "California Series A./ Androscoggin Photograph Rooms,/ Pilsbury Block, Lewiston, Maine." There follows a listing, (also on the verso of the card) of 18 Hart views with correct numbers and titles going eastward to Reno (No. 281). Strangely the view (No. 130) on the front side was not included in the list on the back. Although it is generally agreed that all of Hart's negatives were destroyed in the 1906 San Francisco earthquake and fire, Swackhamer's find might mean that a small group of Hart negatives survived in far-off Lewiston--unlikely, but an interesting possibility. Until recently, the only available list of all Hart's 364 titles was attributed to Charles B. Turrill, who presumably obtained it from Watkins' records. The titles are very short versions of Hart's original ones, and include the 13 views Watkins never published. It is thus probable that the list was compiled by Hart himself and came into Watkins' possession with the negatives he obtained from the CPRR in 1870.

HART'S YEARS AFTER 1869

Hart's transition from "Official CPRR Photographer" to general entrepreneur certainly took some interesting turns over the next few years--traveler, author, publisher, painter, and inventor to name but a few of his later undertakings. A short notice in the *Rocky Mountain News* mentions that a Mr. Hart, portrait painter, had located in Denver during July 1869. Without an awareness of Alfred A. Hart's incredible mobility, this item would seem an argument against his having taken the 1869 photographs of the line
from Sacramento to Oakland.

(Fig. 48) January 1993 in a very dry winter. Frozen waterfall in the snowshed below Crested Peak. In the terrible winter of 1866/67, Gillis described this area as one solid sheet of ice. (MBK photo)

(Fig. 49) January 1993. Looking east in Tunnel 8 toward the snowshed below Crested Peak. During construction, one reached the far end by a tunnel outside in the snow while holding a rope secured to the cliff. (MBK photo)

On the other hand, no initials are indicated in the article and it could have referred to Alfred Hart's son, John, who settled in Denver about that time. In 1870, Alfred A. Hart traveled east at least as far as Chicago, possibly to promote his plan of photographing Pullman Car interiors--the company was located in Chicago--and to put the final touches on his travel book and illustrated CPRR maps. His publisher and the man preparing the book's chromo-lithographs were both in that city. In June of 1872, Hart was back in Sacramento where he was awarded the gold medal for portraiture painting and first prize for the "Most Meritorious Exhibition of Paintings." The *second* prize went to William Keith who, five years before, had prepared a series of woodcuts of the Central Pacific for the *California Weekly Mercury* of San Francisco. These illustrations appeared in various issues from October 1867 to March 1868 and although each is clearly based on a Hart stereograph, rather liberal "artistic license" was apparent and Hart is not mentioned. Hart's first prize may have been even more welcome to him than one would expect!

His personal criteria for excellence in painting and by extension, photography, may be gleaned from the following portion of a written statement he was requested to submit to the 1872 Gold Medal Committee of the California State Board of Agriculture:

> Any painting, to be entitled to high rank as a work of art, must not only be finished in the sense that it leaves nothing more to be added to its composition in the way of thoroughly elucidating the story intended to be told by the artist. It should tell the story at a glance. It should represent nature in a grand manner in her most beautiful and attractive forms and colors...Unity of effect and story are as important to the painter of an epic landscape, and certainly require as much power in the originating mind of the artist who designs and paints it as is involved in the writing of a drama. The highest type of all painting--of all art--is that which, comprehending all the qualities I have enumerated above, joins to them a careful finish of every detail, and which leaves on the mind of the beholder as unmistakable a sign of refined intelligence of the artist who produced it as it is possible to discern in any work of human agency. Upon what principle of criticism the judges could find the qualities I have mentioned as entitling Mr. Keith's landscapes to rank in any respect above mine, I am at a loss to discover...." [68]

In 1874, Hart was still in San Francisco,[69] but the following year he moved to New York, where in 1878/79,
he was a dealer in photographic materials. In 1880, he was back in San Francisco working as a painter. In 1881, Hart was again listed as a resident of New York in his United States

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68. The award for best exhibition of paintings had been given to William Keith. The Gold Medal Committee planned to award medals in each department after the close of the fair. For some reason, they felt uncomfortable with decisions of the judges in one or more of the seven departments ("paintings in oil" was the seventh) and issued a request for statements from the exhibitors of the grounds upon which the medals were claimed.

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art's statement was effective in that the painting department judgement was reversed and the Gold Medal awarded to him. *Transactions of the State Agricultural Society for 1872* pp. 175--177, cited by Pauline Spear. Further information on Hart's paintings is contained in Willumson's article in Appendix E where part of the above quotation also appears.

69. By 1874 Alfred Hart was listed in Langley's *San Francisco Directory* as a landscape and portrait painter, with his studio at 533 Kearney Street.

Patent No. 242,323 for a folding magic lantern which was granted to him on June 14, 1881.
The magic lantern was first described in English in 1674 and consisted of a light source and projection lens capable of casting an enlarged image of a picture on glass placed between the light source and the lens. Hart's improvement involved a sheet-metal lamp house with hinged sides and roof which cleverly folded back around the box containing the condensing and projection lenses.

Again in 1887, at the age of 71, Hart used a New York address in filing for Patent No. 376,802 granted January 24, 1888, and bearing the title "Method of Making Photographic Pictures." As in nearly all process patents, the patent description has the modest literary charm of the Internal Revenue Service writing instructions for assembling a bicycle kit. The patent actually covers a very ingenious method of preparing printing plates directly from photographic negatives "without the intervention of an artist."[70] In Hart's method, the negative was projected on a white surface covered with a black network of wires like ordinary window screen.
The resulting image was then photographed and reduced to the size of the printing plate. The line spacing on the finished plate could be adjusted to any number per-inch by changing the size of the projected image. That is, a large image reduced in being rephotographed gave a high number of lines-per-inch, and a smaller image resulted in fewer lines-per-inch. Further manipulations available in Hart's system included increasing the reflectivity of the black wires by rubbing them with white chalk to darken the highlights in the printed image. He also described the use of a black background screen in preparing three-color printing plates. In making the negative for the printing plate meant to receive red ink, only areas containing reds, oranges, browns, etc. would be rubbed with white chalk (using considerable pressure) so that the background behind the wires became reflective, and an image of those parts could be photographed. After this whitening, and before the exposure, the black wires were rubbed clean.
For the blue plate these red areas would be restored to black by rubbing with a damp rag, and the areas containing blues and greens whitened with chalk. Purple resulted if an area was left white and reflective for both plates. Although not mentioned in the patent, Hart must have worked out the special problem of the projector and the camera not being co-axial so as to avoid distortion in the finished plate.
A passage of particular clarity, which may have been written by Hart himself, begins at line 24, page 3 of the "Specification" part of the patent:

> Either a positive or a negative of the picture may be thrown upon the screen and treated upon the principles described; but there is a special advantage in the use of a negative, whether the shades are to be varied by treatment or not. If a positive were thrown up, the lines or design of the screen would be more distinct in the lights than in the shadows of the resulting picture, while the contrary is desirable. Again, it is the shadows which constitute the greater part of photographic pictures, and it is the shadows chiefly which require treatment upon the screen; but with a positive the shadows are the non-illuminated part of the screen, and those cannot be treated on account of the absence of light there.

This quotation is included to show Hart's detailed knowledge of the subject and to add support to the impression that he had actually *used* the processes described.
These inventions did not bring Hart great financial success, and he seems to have lived on for another 18 years in poverty in New York, attempting to support himself as an artist and receiving financial help from his daughter and son.

70. Then, as now, a photographic image must be divided into thousands of separate points of varying densities to produce a printing plate to which ink will adhere properly. The original is normally rephotographed through a "halftone" screen having dots or lines of 60 to 80 per inch for rough work like a newspaper, and up to 200 or more for the reproduction of fine art photographic books. This process produces the required division of the image to the fineness of the screen, but does not allow manipulation of the densities of shadow areas as suggested by Hart's invention. His process also allowed continuous variation of the lines per inch by adjusting the size of the projected negative.

In 1906, at the age of 89, he was still listed in a New York business directory as a publisher of artistic blueprints. Hart's reasons for his next move are not clear, but sometime in his ninetieth year he returned to California where he later died in the Alameda County Infirmary on March 5, 1908, a few days before his ninety second birthday.[71]
His body was disposed of the next day and although his death was noted under "obituaries" in the *Oakland Tribune*, no regular obituary was published. In the space on Hart's death certificate indicating the "place of burial," the undertaker filled in "For Anatomy." In 1908, the only nearby medical college was at the University of California in Berkeley, where it had been "temporarily" moved from San Francisco after the 1906 earthquake (it was returned to San Francisco in 1958) Their sources of cadavers for dissection were by donor bequest, or from unclaimed bodies. It is not clear under which category they received Hart's body, but in the sad tradition of so many early California photographers, it was probably the latter. Research in this area is difficult as most of the medical school records were destroyed in the 1923 Berkeley fire.
In reviewing the life of Alfred A. Hart, one is struck by the irony that he is known today for his photographic accomplishments, yet he appears to always have regarded himself as an artist, particularly a painter in oils. Even in his last days at the Alameda Infirmary he must have spoken of this, as his death certificate lists his occupation as "artist." There further appears to be no record that in the 38 years after 1870 until his death, Hart ever publicly mentioned his work for the CPRR; possibly because of the circumstances of his termination as their official photographer.

Hart was fortunate in a way that his years in stereo photographic publishing covered a period of relative prosperity in the profession. Almost all his contemporaries in that field were either dead or destitute by 1908 and stereograph publishing was an industry restricted to three or four large firms facing a slowly shrinking market.
Alfred A. Hart did not copyright his photographs, and did not legally pursue people who reprinted them without crediting him. As a result his photographic work has remained effectively in the public domain from the date of first publication, and has appeared (and will continue to do so) in hundreds of books and articles on early photography, Western history, and railroads. For generations to come the photographs of Alfred A. Hart will delight and inform us. As the architect, Sir Christopher Wren, had inscribed by his son near his tomb in London's St. Paul's Cathedral: *Lector, si monumentum requiris, circumspice* ("Reader, if you seek a memorial, look around.")

71. In Appendix E, Willumson gives a very good account of Hart's years after Sacramento.

ABOVE: (Fig. 50) Map (36" x 14") on back of 1875 Central Pacific timetable including times for seven connecting railroads, one river line, one ocean steamer line, and several stage lines. The surrounding woodcuts (each 3" x 3") are all careful copies of Hart's RR views.

LEFT: (Fig. 51) Woodcuts from the center of the top of the map above. The left one is from Hart No. 213, *Snow Covering below Cisco,* and the one on the right is from Hart No. 252, *Snow Gallery around Crested Peak.*

PHOTOGRAPHIC AND PRODUCTION METHODS

This section will focus on the way a photographer of the 1860s took stereo views--particularly Hart's methods--where they can be deduced from the surviving prints. Information is included about photosensitive materials Hart used, problems peculiar to stereo photography, Hart's equipment, and the production of the finished stereo cards.

The technical side of photography, including stereo or three-dimensional-imaging, has long attracted the interest of great scientific minds. Enjoyable as it would be to have such an expert explain Hart's photographic techniques, the following remarks are written mainly from a practical standpoint. Consequently, they may not answer all of the questions which would occur to a reader, but the facts given should provide a basis for additional research.

METHODS IN THE FIELD

Hart's energetic approach and almost total disregard for his personal safety while taking photographs is not immediately apparent in every CPRR stereo, but it is clearly demonstrated in a number of his views.[72] In fact, getting his heavy camera and tripod to high places to record scenes from the tops of locomotives, box cars, and various cliffs were almost his trademark.

An especially large number of Hart's CPRR views in Nevada and Utah are taken from the tops of boxcars which required climbing a narrow vertical ladder. Likewise the difficulties in getting from the tracks to the camera location at the very top of the Palisades (No. 340) must have been a story in itself.

As he grew older and the railroad progressively longer, Hart seemed to become rather more conservative about climbing on locomotive cabs. From Lost Camp Spur (No.162) at 80 miles from Sacramento to Promontory Point (No. 357) at 690 miles, he published no photographs taken from the roof of a locomotive cab. However, this may have had far less to do with his declining agility and more to do with the locomotive engineers objecting to leaky cab roofs caused by the sharp points on the legs of Hart's camera tripod (See Fig. 66 p. 94).

Hart clearly understood the great importance of placing his stereo-camera at an elevated position in order to de-emphasize uninteresting foreground areas that might result from his relatively wide-angle lenses. For example, No. 242, "West of Clipper Gap", when viewed as a single image initially appears to have been taken from the level of the roadbed alongside the track. Examined in stereo, it is seen that the camera and the standing man are actually about 20 feet above the rails. Hart, unfortunately ignored this rule at Promontory in No. 360, "The Last Act", with rather disastrous result. More likely he

72. The camera locations have to be visited to fully appreciate the difficulty in reaching some of them. A clear example of Hart's daring is seen in his view of Bloomer Cut (Appendix A, No.10) taken from the middle of the narrow flume spanning the cut 60 feet above the tracks. Others photographed Bloomer Cut, but no one else set up on the flume itself and covered his head with a dark cloth while inspecting the ground glass for focus and composition. The same flume appears overhead in a later view taken from the bottom of the cut (No. 12). Hart's No. 44 (looking down on a locomotive at Cape Horn) looks only slightly difficult from the stereograph itself, but the camera location is very hard to reach from the tracks and an absolute terror for setting a tripod.

remembered the rule, but hadn't brought a ladder such as the one seen at the left background in No. 357 and employed by the Union Pacific photographer, A. J. Russell, to take his world-famous "Handing the bottles" view of the two locomotives meeting.

A century and a quarter later, by carefully lining up the road bed with distant features of the landscape and correcting for differences in field-of-view, it is still possible to find in many cases the exact point where Hart set his tripod. After personally locating dozens of such sites, it is easy to state that Alfred Hart was quite literally something of a tough act to follow.
In stereo photography, in order that the eye and brain can work the miracle of depth perception, two images must be taken, usually with about the same separation as human eyes -- about 2-5/8 inches. Occasionally with larger formats, greater separation was employed, and a smaller separation for close-up stereo photography. For non-moving objects the two images can be taken with a single lens camera if it is shifted latterly the appropriate distance between exposures. In *normal* work, where the two images were taken on a single negative at the same instant, a special camera equipped with two lenses was required (Fig. 58.)[73] All of Hart's stereos appear to have been taken with such special cameras. An experienced stereo photographer tended to seek camera locations that would exploit the camera's ability to record depth. Interiors of snowsheds, tunnels, and bridges were obvious targets.
With lenses only inches apart, the stereo camera could not differentiate the distance between objects located near the horizon on the Nevada desert, or the separation between mountains in the next range in the Sierra. Such scenes could be vastly improved by including something distinctive, or dramatic in the immediate foreground, usually within 15 feet of the lens.

For Hart the unbeatable "something" was the top of a locomotive boiler, or the railroad rails traversing a cliff near his camera with a valley far below.

LIGHT SENSITIVE MATERIALS

In the 1860s, when Hart was first taking his railroad views, the pioneer daguerreotype method had already declined in popularity and the wet collodion process was in vogue. This involved carrying glass plates which were, just before use, coated with iodized collodion (a viscous mixture of gun-cotton dissolved in alcohol and ether) and sensitized by dipping in a silver nitrate solution. The final step had to be done in a dark tent (described at end of Appendix F) by the dim light from a small translucent panel of yellow or orange silk.

Coating, sensitizing, exposing, and developing had to be completed before the plate dried, in a total period of five to ten minutes (depending on temperature and humidity), or the plate would lose sensitivity. In addition to leaving the camera looking as if one had been cleaning fish in it, the sensitizing and developing procedures stained the operator's hands; and the plates, both before and after exposure, were heavy and fragile. Photographers utilized this messy process because the resulting negatives displayed a beautiful long tonal range, required a shorter exposure than the earlier methods, and could be used to make any number of positive paper prints. While it appears that no Hart negatives have survived to this day, it is possible to estimate their size as 5-inch by 8-inch from a wonderful collection of contact prints at the Society of California Pioneers in San Francisco and from other contemporary wet-plate cameras which generally employed the 5-inch by 8-inch format.

Such glass plates were 1/16-inch thick and weighed three and

73. The term "twin lens camera" has not been used here because camera collectors and antique camera dealers occasionally use this term to describe a twin lens reflex camera, such as a Rolleiflex.

one half ounces each, or two and one half pounds per dozen (the normal number in the portable plate box).[74]

THE WET COLLODION PROCESS

This revolutionary photographic method, referred to as the "wet-plate process" was invented in 1851 by Frederick Scott Archer. A butcher's son, Archer was born in 1813 in Hertfordshire, England, and later became a London portrait sculptor. To assist him in this work, he used calotype (paper negative) photography, but vastly improved upon it by using the newly-invented collodion on glass as a substitute for the paper support.[75] The layer of collodion was very thin relative to paper and was as transparent as glass. Properly formulated collodion adhered tightly to the glass base, but unfortunately collodion which had dried (by the evaporation of the alcohol and ether solvents) was impermeable to water. This prohibited the introduction of the water-based compounds needed to develop and fix the latent image.

Archer's stroke of genius was the concept of *completing the sensitizing, exposure and development of the negative before the collodion had dried*, possibly because the developer was now allowed to enter the spaces occupied by the alcohol molecules. The result was a revolution in photography that lasted over 30 years. Archer's process was easier and cheaper, had an effective film speed that was at least ten times that of the daguerreotype and the retention of details almost equalled the earlier process. The main advantage of the new technique was that *any number* of fine paper prints could be made from the same transparent negative.

Archer made a related invention in 1852 called the positive collodion process. In an "ambrotype," as they were named in America, the collodion was made thinner, the deposited metallic silver was whitened with bi-chloride of mercury, and the glass negative was blackened on the back to make an image which appeared positive. Within a few short years of its introduction in 1854, the ambrotype had largely replaced the daguerreotype for popular portraiture. The tintype or melainotype used a similar process, but employed a blackened sheet of iron as the base. In California, portraits were also occasionally produced on black leather, or oilcloth because they could be carried or mailed without danger of breaking.

Frederick Scott Archer published his wet-collodion process in 1851 without asking any compensation and was rewarded shortly thereafter by being named the defendant in a law suit filed by William Henry Fox Talbot, claiming this was all just a copy of his calotype process. The case was dismissed, but Archer died in poverty on May 2, 1857 at the age of 44.

His wet-collodion process was used on every continent and survived with the work of itinerant tintype photographers well into the early twentieth century.[76]

In rural California in 1865, Hart had to be prepared to produce his photographic emulsions from rather basic

74. The prints mentioned were given to the Society of California Pioneers by Charles Turrill, who assisted Watkins in his later years. In this collection, the order and selection of the images are those used by Watkins in his published CPRR series although the album titles are considerably shorter than the ones Watkins used on the cards. The Pioneer contact prints are square, but larger than the images published. They include portions of the limit of the image circle of the lens. The glass negatives seem about 5 by 8 inches, although the negative's edges are not shown in the prints.

75. The calotype process had been patented (No.8842) in 1841 by William Henry Fox Talbot (1800 - 1877) and used a paper negative impregnated with silver iodide as the light-sensitive agent. The name "Calotype" was given by Fox Talbot from the Greek Καλος=beautiful + Τυπος=type. Hart did not use paper negatives, but the details of the process are relatively simple, and are included in a number of histories of early photography, including Mike Weaver, *The Art of Photography* (New Haven & London, Yale University Press, 1989) p. 13.

While the calotype process produced artistically beautiful images, fine image detail was not equal to that available in the daguerreotype or the wet plate process. There were two problems with paper negatives, the relatively thick layer of sensitive material distributed throughout the paper caused poor definition, and the fibrous opacity of the paper interfered in making prints by transmitting light through the paper negative.

76. For further information on literally hundreds of early photographic processes, the reader is referred to Luis Nadeau, *Encyclopedia of Printing, Photographic, and Photomechanical Processes* (Fredericton, NB, Canada: Atelier Luis Nadeau, 1994). This two volume work (in one) contains separate indexes for names of people and names of processes and excellent cross references.

materials, some of which were explosive and some poisonous, although none were both--unless one considers the fumes of ether as a poison. Thus, it is not surprising that photographers of his era also became chemists to a degree determined by their distance from a metropolitan center of photographic supplies.

There was some published support available in that the instructions for the preparation and use of the materials of the wet-plate or collodion process could be found in books, articles, and occasionally from the writings of the photographers themselves. Most of the data in this essay (including the woodcuts) were obtained from a single small book called *A Popular Treatise on Photography (1867).*[77] The perhaps excessive details are included to give the reader some idea of the great difficulties and actual hazards faced by Alfred A. Hart in practicing wet-plate photography. (An amazing complexity by comparison with today's point-and-shoot picture taking.)

NECESSARY INGREDIENTS

Assuming that factory prepared photographic collodion was not available, the following raw materials would be needed to prepare it. For the iodized Collodion:

1. Ordinary cotton free of impurities
2. Saltpeter, (potassium nitrate) finely granulated
3. Sulfuric acid
4. Small ingots of metallic cadmium
5. Crystalline iodine
6. Liquid bromine (vapor highly injurious and corrosive, very volatile--therefore kept under water)
7. Clear filtered alcohol
8. Thoroughly washed and distilled ether

Items 1, 2, and 3 were used to prepare gun cotton which was invented by a German chemist in 1846.[78] Photographic "iodized," or "sensitized" collodion was prepared shortly before use by mixing two *very stable solutions* that could be kept for long periods, i.e., plain thick collodion and the iodizing solution.

Plain collodion was prepared by mixing guncotton with a solution of 22 percent alcohol and 78 percent ether, strongly agitating, and allowing the resulting mixture to settle for several days. The clear solution was then poured off into smaller bottles for use (solution No. 1) as needed for mixing with the iodizing solution within 24 hours of use. Iodized collodion had to be kept in the dark in well-stoppered bottles. If kept more than 48 hours, there was a tendency for its sensitivity to be reduced.

The viscosity or "thickness" of collodion could be increased by adding more guncotton, or reduced by adding more alcohol and ether.[79] The iodizer (solution No. 2) was prepared by

77. D. Van Monckhoven, *A Popular Treatise on Photography also a description of, and remarks on The Stereoscope and Photographic Optics* Translated by W. H. Thornthwaite, Ph.D. (London: Virtue and Company, 1867). This small book, 6-7/8"x 4-1/4" with 136 pages of text is a veritable gold mine of information. My own copy used here, was obviously well loved, and contains much pencilled underlining. (The book was a gift of Allen Weiner of New York.)

78. Guncotton or "Pyroxyline" which looks much like ordinary cotton, but is heavier, more brittle, and of a yellowish color, was invented by Prof. Christian Schoenbein in 1846 while seeking a form of nitro-cellulose suitable for a smokeless propellant in military weapons. Due to the great rapidity and violence of its detonation, gun cotton tended to rupture the gun before the projectile left the muzzle. In 1887, Nobel finally produced a successful smokeless propellant and reduced the violence of gun-cotton by mixing it with one and one-half times its weight of, amazingly, nitroglycerin.

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ilitary guncotton was about 14 percent nitrate and was insoluble in alcohol, ether, or a combination of both. Guncotton for collodion was 11 percent nitrate, slightly less explosive, and soluble in neither alcohol nor ether alone, but dissolved readily in a combination of the two.

79. The ether employed was volatile, and the fumes heavier than air, and explosive. If a lamp was used for illumination, it had to be kept well elevated above the work area to avoid detonating the gaseous ether.

dissolving cadmium iodide and cadmium bromide in alcohol. This solution was then carefully filtered into smaller bottles. Solutions No. 1 and No. 2 could be preserved for any length of time if kept separately in tightly closed glass bottles.
Four ounces of sensitized or iodized collodion was prepared by mixing, by volume:

Thick plain Collodion(No. 1)	26%
Iodizer solution (No. 2)	10%
Alcohol	19%
Ether	45%

Immediately after being well shaken to mix the ingredients, the sensitized collodion was ready for use, but was improved by a delay of a few hours.
The most desirable glass plates were true "plate glass"; that is, the surfaces were ground flat and parallel, with the edges smoothed after cutting to size with a diamond point glass cutter.

(Fig. 52) Equipment for polishing glass plates. Tripoli bottle, plate clamp, and plate holder. (Van Monckhoven, 1867)

For smaller sizes like one half plate (6-1/2-inches by 4-1/4 inches), ordinary window glass could be used. Whatever glasses were employed, they had to be cleaned and polished before coating with collodion. The plates were first immersed for one hour in dilute nitric acid or a 50 percent solution of carbonate of potash. After this they were thoroughly washed and allowed to dry in a rack in a dust-free atmosphere.
The plates were then polished on the side to be coated with a mixture of tripoli powder and alcohol spread with cotton, and finished when dry with an exceedingly dry chamois. It was recommended that this cleaning and polishing should be done within 12 hours of use.

The polished plates were immediately placed in an absolutely dust-free box having internal grooves (to separate the plates) for transport to the point of coating.

PREPARING THE PLATES FOR EXPOSURE

The iodized collodion was flowed onto the plate and the excess caught in a small bottle, and the plate was then tipped back and forth to ensure an even coating over one side of the entire plate.[80]
Up to this point, the operations described could be carried out in daylight. The following steps which included sensitizing the plate, loading it in a holder, unloading the holder after exposure, developing, washing and fixing had to be done in subdued yellow or red light. In Hart's case this occurred either in a dark tent or the darkened area of his photo-wagon.
Depending on the temperature, within 20 to 60 seconds[81] after coating the plate with collodion, the plate was (Fig. 53) The dark chamber, including the yellow filtered window at right. The intensity of the light could :be varied by shortening the chain on the shutter at its bottom. (Van Monckhoven, 1867)

dipped in a narrow glass tank filled with enough 9 percent silver nitrate solution to cover the plate. A hook made of silver plated wire, gutta percha, or whalebone was used to support the plate

80. Although this sounds like a rather simple process, it was correctly regarded by Hart's contemporaries as critically important to making good photographs. As the iodized collodion flowed across the plate being coated, some of the ether and alcohol evaporated. Because of its greater volatility more of the ether was lost, and the collodion thickened. After a few plates had been coated, the lost ether and alcohol had to be replaced by addition to the working iodized collodion solution. Even with collodion of ideal viscosity, great dexterity was required to deposit it in the correct thickness and smoothness; particularly in coating large plates. Iodized collodion was very unstable and sometimes for no apparent reason it became "slow" (The film speed dropped, requiring much longer exposures). At other times, it turned red before exhaustion, requiring total replacement. Good collodion was of a very light yellow color or occasionally clear.
81. An indication of the importance of skill in this matter is given by Van Monckhoven in describing the interval between applying the collodion and dipping the plate in the silver nitrate solution..."the plate is ready to be immersed in the nitrate of silver bath; but it is always advisable to wait a few seconds (and how many, experience alone can indicate precisely), so that the film may be sufficiently 'set'." It was obviously critical that the collodion be fully attached to the glass before being dipped in the sensitizing solution, yet not so dry that it was impermeable to the solution.

as it entered and was removed from the tank. The plate was gently moved up and down to minimize streaks and then smoothly withdrawn from the bath.
In addition to glass, silver nitrate solution tanks were available made from gutta percha, porcelain, and an American product called *Mathiot's Photographic Ware*.

(Fig. 54) Coating the plate with collodion. (Van Monckhoven, 1867)

The film of collodion turned white due to the conversion of iodide of cadmium to iodide of silver, which is sensitive to light. The wet, sensitized plate was then loaded into a plate holder ready for exposure in the camera.[82]

The next step involved the use of the camera, its lenses and associated support items. A full description of Hart's camera equipment would be logical at this point,

(Fig. 55) Receiving the used collodion into a bottle for later addition of ether and alcohol evaporated during the coating process. (Van Monckhoven, 1867)

82. Plate holders of Hart's time were closed at the front or lens side, with a thin, light-tight sheet of metal called a "shutter", which could be moved in and out while the holder was attached to the camera. In later years this device was referred to as a "dark-slide."

Usually holders for wet plates held a single glass sheet, secured in the holder by silver plated wires or glass corners. After 1885, holders for dry plates often were double faced allowing an exposure on each side.

but in deference to the fact he had to follow through with the development of the plate within five minutes of coating, the description of his camera will be deferred until later.

DEVELOPING AND FIXING THE NEGATIVE

The developing process reduced the exposed portions of silver iodide to opaque metallic silver. This was followed by washing off the chemicals used, and fixing with hyposulfite of soda to remove any unexposed silver compounds, followed by another washing. Until the negative had been immersed in the fixing or hyposulfite bath, it had to be kept out of white light (dim red or yellow light was permissible). In Europe the developer often used in the early 1860s employed pyrogallic acid. This material was rather unstable and tended to decompose in a day or two.

(Fig. 56) Glass silver nitrate solution tank used to sensitize the coated plate. A surviving example which would have been the right size for Hart's plates has inside dimensions of 9" deep, 7" wide and 3/4" thick.

The silver plated devices to lift the plate out of the bath are shown at the left, but even using those did not protect the photographer's fingers from the blackening effect of the silver nitrate (Von Monckhoven).

Even the water used was best distilled or filtered rainwater (being careful to avoid that gathered during a storm, because lightning converted some of the atmospheric nitrogen into ammonia and nitric acid). Hart, on the other hand, probably used the iron development system (based on sulfate of iron) because it greatly reduced the length of exposure and was popular in the United States. The developer was prepared by mixing:

Saturated solution of iron sulfate 15%

Water	78%
Glacial acetic acid	5%
Alcohol	2%

About four ounces of this solution were placed in a small glass and from it poured over the negative to be developed, starting at one corner. The excess developer was caught in the same four-ounce glass, while the negative was tilted back and forth. This process was repeated until all of the details of the image appeared, although very faintly. Then the iron solution was poured off and a weak solution of silver nitrate poured over the surface of the negative and spread again.
(Fig. 57) Developing the negative. (Van Monckhoven)

After the silver nitrate had spread over the whole surface the original developer was again poured over it and spread by tilting. The contrast or intensity of the image was increased from the original faint image by each application of the silver nitrate solution. This required frequent inspection in the dim light of the dark tent to avoid over development.
For thin or underexposed negatives it was sometimes necessary to repeat the addition of the silver nitrate two or three times.

As soon as the negative reached the desired level of intensity in the shadow areas, the development was halted by washing with water. At ordinary temperatures the picture was sufficiently developed in two minutes, while at the higher temperatures Hart encountered, 30 seconds might suffice. To quote Van Monckhoven: " Experience alone can give the knowledge necessary to determine exactly the when and how in this delicate operation."[83] Care was also necessary in washing off the developer to avoid detachment of the fragile collodion film from the glass plate. After washing, the unexposed portions of the negative still retained the yellow-white appearance of the original silver iodide. This was removed and the negative "fixed" by immersing it in a 17 percent solution of hyposulfite of soda until the last traces of the pale yellow silver iodide had disappeared.
A few seconds after the negative was placed in the hyposulfite bath, the tray containing it could be taken into daylight allowing the photographer to confirm when the silver iodide had been completely removed, and ordinary daylight from that time had no action on the picture. The time required in the hyposulfite varied from 30 seconds for
a fresh solution to a few minutes for one that had been much used. When the fixing was complete, the negative was carefully washed, first with a fine jet of water and then by immersion for at least 5 minutes in a clean water bath.
To a modern photographer, washing the negative after fixing is generally a signal to relax. In Hart's day, however, it could be a time of great anxiety. The problem was that during washing the collodion film might become partially or wholly detached from the supporting glass. The detachment usually started at the edges of the negative; so the fine water jet from the washing bottle was always directed at the center of the plate allowing the water to run outward over the edges.
Poor adhesion could also result from the use of impure guncotton, an insufficiency of ether in the collodion, improperly cleaning the glass prior to coating, or wash water that was too warm. A variation of the problem sometimes arose when the negative was placed on one edge to drain, and the collodion film could wrinkle and sag of its own weight.
This latter situation could sometimes be corrected after the excess water had drained away by very carefully drawing the emulsion to its proper position with a finger. Detachment of parts of the emulsion, while in the washing bath, was occasionally corrected by the gentle removal of
the plate and returning the detached portions of the film "by a very fine and light jet of water applied to the required

83. Van Monckhoven's *A Popular Treatise on Photography,* 1867 (cited earlier) was a "free translation...[with] alterations and emendations...in the original text" by W.H. Thornthwaite into English. Consequently some odd constructions of language may have resulted from the literal translation of the French original.

places."[84] After final washing the plate was placed on its edge on an absorbent surface and leaned against a wall to dry, collodion side out if in a hurry and collodion side to the wall if dust were a problem. In summer, in the Sierra or on the Nevada desert, Hart's negative would dry in less than ten minutes and he could then be ready to move his equipment to another location.

To summarize, under ideal conditions, using the wet collodion process and iron development, Hart could take about one exposure every five minutes, with an assistant handling the final washing and drying.

If required to dry the finished negative and pack it to move to a new location, Hart needed at least 15 minutes between photographs (longer under humid or cold conditions).[85]
From his stereographs, it appears that Hart worked out some method of taking at least two and probably three or four exposures within minutes of each other. Several possibilities have been suggested for slowing the evaporation of solvents from the exposed plate, so that time could be available to expose several negatives in succession, or even allow transport to a more convenient location before development.

However, if Hart did occasionally make multiple exposures before developing, he would probably
have preferred a dry collodion process in which the collodion was sealed in by a preservative to be later penetrated by a developer in the proper solvent.[86]
All of these dry processes had certain disadvantages in comparison with the regular wet collodion process, but they did eliminate the need for carrying a dark tent and chemicals to the camera site. The preparation of the plates for processes A. and B. (in the table above) were long and critical procedures, but seemed to yield the best detail in the finished negative. The rapid acceptance and enthusiasm with which commercial dry plates (based on sensitized gelatin) were received in 1881, would tend to confirm that the earlier dry collodion was only really useful in special situations.

In both wet-plate and dry-collodion processes, except the collodion-albumin, the finished negative was coated with clear varnish on the collodion surface. This was necessary because this image surface was fragile and would quickly wear or abrade without protection. At the same time, printing paper coated with albumin sometimes became sticky in damp weather and could pull off parts of an unprotected negative. In making hundreds of prints from a single negative, Hart would have had to revarnish the collodion surface at frequent intervals.
To the reader, it should now be obvious that Hart and others using the wet collodion process could vary virtually every characteristic of their photographic emulsions by design or error. They could change the concentration and composition of the sensitizing and developing solutions in addition to the timing of each operation. Thus, in every beautiful negative where the photographer's artistic ability was obvious, lay a hidden and almost superhuman attention to the details of the photo-chemical process.

HART'S CAMERA AND EQUIPMENT

84. Van Monckhoven, p. 67. The author further mentions "We have often in this way replaced a film upon the glass after it has been entirely removed and torn at the edges, and obtained good results."

85. In Hart Nos. 154 and 155 (Appendix A) taken at Green Bluffs, the shadows on the locomotive have moved imperceptibly, and the people only short distances, while Hart moved his camera at least 100 feet along the bluff above. In No. 239, *Snow Plow at Cisco*, the snow on the front coupler has only melted a little from its appearance in Houseworth No.1263, printed from a Hart negative taken moments earlier. A similar short interval occurs between Hart Nos. 169 and 170 taken just before Houseworth No. 1266.

86. The evaporation of water from the developed plate, or of alcohol and ether from the un-developed plate could have been delayed in the following ways: If handled gently, the negatives could have been immersed in a tank full of cold water, before or after development. Also a coating such as water-glass, or albumin could have been applied before development.

Without written records, the exact details of Hart's photographic equipment are unavailable. It is clear, however, that he employed stereo cameras common in the 1860s, as evidenced by the inspection of contact prints made from his negatives, the two of his published stereographs that actually show a camera (Appendix A, Nos. 179 and 188 [a]), and the shadow of his camera appearing in a few of his published stereographs. One hundred and thirty years later, working, wet-plate stereo cameras are very hard to locate, but a New York dealer, Allen Weiner, kindly provided one made by Otto Loehr of New York which is shown in the photograph on p. 90. (Fig. 58).

As Hart's would probably have been, this camera is entirely American made, with the high quality lenses manufactured by John Dean of New York. The outfit[87] is provided with a fitted hardwood case containing the camera, a spare lens-board for single lens operation, a box of metal diaphragm or "f/stops," the two lenses, a black focussing cloth, two removable "septums" or flexible center dividers which kept the images apart in taking stereos, and two 5-by-8 inch negative holders.[88]

87. The lenses have serial numbers 6661 and 6664 engraved on their barrels and are made with three elements, or separate internal lenses. Their focal length is 7-1/2 inches with the maximum aperture F/4.5 (Hart's were of about 6 inch focal length). Each lens is separately focussed with a brass knob which controls a smoothly operating internal rack-and-pinion. With the brass lens shade in place each lens covers a 5" diameter circle on the negative (working circle). For panoramic work, with the shade removed, each lens covers a 7" circle.

88. This wood and brass camera was manufactured by Otto Loehr of New York City and distributed by E.& H Anthony. It uses 5"x 8" glass plates, has interchangeable lens boards, no provision for a shutter, and a few of the adjustments available on modern view cameras. The back tilts about 15° each side of vertical, and a small vertical adjustment of about half an inch up or down is provided for the lens board. The rise and fall of the lens board allows the photographer to include more or less of the foreground while still holding the camera level.

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ocussing is done first by sliding the back in and out along the bed, and then by fine adjustment with the knobs on the individual lenses. This also allows correction for slight differences in the focal length of the lenses.

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he opening for the ground glass focussing screen, and the glass negative, is 5 inches by 7-3/4 inches. This opening is vertically divided in the center by the rear support of the pleated septum which extends to the lens board and eliminates overlap of the images from the two lenses. The space for each of the two individual images is 5 inches high by 3-3/4 wide. The septum is removable and a spare lens board with a single central opening is provided, allowing single lens panoramic photographs to be taken. No. 2(a) in Appendix A may have been taken by Hart in this way.

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he bellows between the back and front stands are made of leather. With the lens board removed, the bellows compressed, and the bed folded upward, ready for insertion in its case, the camera measures 10-1/4"x 9-1/2"x 5" and weighs 5-1/2 pounds. In stereo and panoramic cameras no provision for a vertical format is needed, and thus only one tripod bushing required. At the back of the camera, on the bracket that supported the wet-plate holder, the wood has been deeply stained by the silver nitrate that leaked from the holder while the dark slide was removed during exposure.

(Fig. 58) Wet-plate stereo camera of the 1860s. The lens caps in the foreground were used to time the exposure, and the slits to accommodate the removable diaphragm stops are just above the focus-knobs. (MBK photo)

(Fig. 59) Print from a full 5" x 8" stereo negative taken with the camera shown in (Fig. 58). The print images have *not been transposed*. Points AA in the distance are *closer* together than points BB in the foreground, and the head seems shifted to the left in the left image. For stereo viewing the reverse must exist and is accomplished by cutting the print and interchanging the left and right images. (60% of original size.)

views taken with the septum removed.

RIGHT: (Fig. 61) Clockwise from the top: Lenses and stereo lens-board for the camera in (Fig. 58), septum which separates the space behind the lenses and is accordion pleated so the back of the camera can move back and forth in focussing, two pairs of (Waterhouse) diaphragm stops (f/18 and f/11), and on the left the lens-board used for single lens panoramic views taken with the septum removed.

(Fig. 60) Full print with single lens at center of lens-board. The edge of the lens's working circle is clearly shown. Taken with the wet-plate panoramic camera pictured inside the front flyleaf. (MBK photo)

LEFT: (Fig. 62) Hart No. 44 of locomotive HUNTINGTON on Cape Horn with his regular lens. Looking SW from the cliff above the tracks.

RIGHT: (Fig. 63) Hart No. 44 taken from a few feet to the left with a camera having lenses with double the focal length of the those used for (Fig. 62). The distant bridge over the American River is twice as long in this view.

BOTTOM LEFT: (Fig. 64) Portion of Hart No. 188 (a) showing his large camera and carrying strap.

BOTTOM RIGHT: (Fig. 65) Portion of Hart No. 179 *Old Man Mountain*. Looking south from near Meadow Lake. Hart is thought to be the man resting his hand on the same large camera at the left, while his dog looks at the camera or the man in front of it

In the field, Hart could move his camera short distances while still attached to its tripod (the large camera strap shown in Appendix A, Nos. 179 and 188[a] may have facilitated this). Assuming his equipment was closely similar to the example previously described, this outfit would weigh:

Camera	5.5 pounds
2 lenses on mounting board	3.5
Dark cloth	1.0
2 loaded plate holders	3.0
Tripod and attachment hardware	5.0
Total	18.0 pounds

This, of course, covered only his minimum outfit. As mentioned

later, Hart also used a another, larger, and heavier camera. It required a stronger tripod and was provided with a leather or fabric shoulder strap, perhaps for carrying the camera separately or with the tripod as described above.

Hart would have used photographic lenses constructed with from two to four elements. Those with only two elements gave the optical designer limited ability to correct aberrations in the optical images formed, but they still worked reasonably well. Four element lenses were better, but more expensive to manufacture. Fortunately the wet-plate emulsions were highly sensitive only to blues and greens thus reducing the problem of chromatic aberration (the inability to bring light of all wavelengths to focus at the same point). In addition, most other lens problems were reduced by using the small f/stops [89] needed for the greater depth-of-focus in stereo photography.

The largest apertures were around f/8 for average quality lenses and up to f/4.5 for the more expensive ones. Focal lengths tended toward wide angle for the negative being used.[90]

From evidence found in Hart's published stereos, he used at least two different length lenses in taking his photographs. His usual lens covered a circle of 4-7/8 inches. By comparing twentieth century images of the same scenes with Hart's views, this lens appeared to be slightly wide angle; about a 6-inch focal length having a coverage similar to a 30 millimeter lens on a modern 35 mm format. His longer lenses had focal lengths about 2.1 times as long, comparing to a 65 mm lens on a 35 mm format.

In estimating comparative camera focal lengths from contact prints, one must examine variations of negatives taken of the same scenes, to determine if lenses of different focal lengths were used while the camera location, and objects photographed remained the same. If the negatives were available, the larger image circles resulting from the long lenses would make the determination easy, but in Hart's case it must be done by finding specific instances where he took the same scene twice from about the same place and published both results.

A comparison of the size of an object in the foreground of two views of the same location cannot be used alone,

although from the same location a longer lens would produce a larger image of this object on the negative.[91]

The two photographic images must be carefully compared to insure the foreground is similar and that the *distant* objects appear larger with the longer lens. In general, long lenses *compress* the background. That is, objects on the horizon (or over 500 feet away) appear larger and therefore closer to the foreground (see Fig. 63)

By comparing the separation of two summits on the distant mountains in Hart No. 109 and 109(a), it can be seen that his long lenses were about 2.1 times the focal length of the shorter ones. If the short ones were of 5 to 6 inch focal length, (estimated from the image circle and angle-of-coverage mentioned earlier), then Hart's larger camera, with the longer

89. The amount of light passing through a lens is controlled by the aperture, which can either be fixed or adjustable. The adjustment can be continuous with a diaphragm set by turning a ring, or in steps by inserting in the light path, metal plates (called "stops" or "Waterhouse stops") with holes of different sizes. The "f/ stop" is the focal length of the lens divided by the actual diameter of the opening of the stop or adjustable diaphragm and is inversely proportional to the size of this opening. That is: the larger the actual opening the smaller the f/ stop number.

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he depth of focus, or the distance between the farthest and nearest objects in focus, is increased by reducing the size of the aperture. Stereo photography is most effective when far and near objects are in the same scene, and to keep both such objects sharp and in focus, small apertures (with large f/ stop numbers) are needed.

90. As a rough rule, a "normal" lens has a focal length equal to the diagonal of the negative. "Wide angle" lenses have shorter focal lengths and "Long" or "Telephoto" lenses have focal lengths greater than the diagonal of the negative. See also Appendix F, p.207, under "Negative and Lens sizes."

91. A larger foreground image could also be produced with the regular lenses by just moving the camera closer. A clear example of this latter procedure can be seen in Appendix A Nos. 217 and 217(a) taken to the northwest at the passenger station in Cisco. In both views, three white trees on a hillside (about a half-mile away) can be seen above the wood pile at the right, and they remain the same size in the two views. Although the locomotive YUBA is much larger in No.217(a), and the camera is further to the left. The larger locomotive results from moving the camera a few feet closer and not the use of longer lenses. If the long lenses had been used in No.217(a), both the distant trees and the locomotive would have appeared larger in No. 217(a) than in No. 217.

bellows extension, would have had lenses with about 10-1/2 to 12 inch focal length.[92]
Since around 1895 when the Carl Zeiss Company

began producing lenses which were true telephoto lenses (with a negative lens at the back), an effectively long lens can be used on a small camera, with no appreciable change in the lens-to-film distance. Such lenses were not available in Hart's day and to use a long lens giving a bigger image, he had to employ a camera with a lens-to-film distance at least two and a half times that of his small camera. Hart could have accomplished this in several ways, but he simply obtained a larger camera which accommodated the longer lenses. The two scenes which include a large camera at the left, confirm that he kept his long lenses on a different, and larger, camera. In addition, if he had just changed to long lenses on his regular camera, why would he then have picked up the camera and moved it to the left for the long lens exposure? (See Appendix A, Hart Nos. 44, 44 [a], 109, and 109 [a].)
If, as the evidence seems to show, Hart used two different cameras in his railroad series, he always placed the long focus camera on the left, and often a bit lower. The two instances where a large camera is included in a view (No.188 [a] "Castle Peak" and No.179 "Old Man Mountain"), we see this Fig. 66) 1860s Tripod.
camera lower and to the left.

In No. 109 *Summit Valley* (long lens) the camera is to the left of its position in No. 109(a), but the elevation seems about the same. In No. 44 "American River" (long lens), by noting the position of the smoke stack against the distant brush, it can be seen that the camera was lower and to the left of its position when taking No. 44(a), an obvious wide angle shot.No. 258 "Castle Peak from the Railroad" and No. 258(a) illustrate similar positions. Possibly because of its size, Hart did not take his long focus camera to Promontory, while Russell did, with superior results. Compare Hart's No. 357 from UP locomotive 119 (Fig. 26) and A. J. Russell's view from the roof of the cab of the JUPITER. (Fig. 27)

SHUTTERS

Hart's substitute for a modern shutter was to time the exposure with his black focussing cloth draped over the lenses and removed for the correct time, or the lens caps could be used for the same purpose.[93] From the actual photographs, without knowing the aperture size, it is generally difficult to estimate the exposure times employed by Hart.
The existence of ghost images, occasional movement of people and horses in the outdoor scenes and fuzzy views of flowing water would suggest something longer than one second, but how much longer is difficult to say. Clear images of little children, as at the left in Fig. 18: *End of Track on Humboldt Plain* would probably mean an upper limit of 2 or 3 seconds, and possibly less.

A remarkable Hart stereo view published without a printed title or number and taken in the Senate Chamber of the California State Capitol, includes a clock at the back of the room (Fig. 67).[94] The minute hand of this clock has moved over about

92. The focal length of a single positive glass lens is the distance from the center (back to front) of the lens to the ground glass when an object at infinity is in sharpest focus. The center, or "nodal point" of a compound camera lens made up of several single lenses is not usually just halfway between the front and back glass surfaces. As a result, directly measuring the focal length of a camera lens with a ruler is difficult. An accurate determination of focal length can be made by focussing the lens first on an object at least 300 feet away and measuring the distance from any point on the lens to the ground glass. The lens is next focussed on a close object producing a full size image of the close object on the ground glass and the distance, from the same point on the lens used before, to the ground glass is measured. The difference of these two measurements is the effective focal length of the lens.

93. With just a little practice, the two lens caps on a stereo camera can actually be used for one second exposures and will work better than the dark cloth, especially in a wind. Longer exposures are, of course, easier to make. The trick is to have the caps tight enough so they won't fall off in the brush, but still be easily removed for the exposure. A tiny drop of pine pitch inside the rim of the cap seems to work well.

94. Sacramento City/County Archives and Museum Collection. File No. 81/149/04. The old State Capitol Building containing this room was located at 7th and I Streets in Sacramento and

three minutes during the exposure. The time indicated is during the noon hour and light is coming from the high and seemingly large windows of the chamber. Assuming the senators needed enough light to read the fine print on the bills being considered (a brightness scale reading of six on a modern exposure meter) and that Hart selected a stop such as f/32 to get the depth of field needed in interior stereos, then the exposure mentioned would suggest a film speed of ASA 9.
This same film speed on the bright Nevada desert (brightness scale 13) would require f/32 at 2 seconds. Likewise, inside the tunnel shown in No. 197: *Summit Tunnel before Completion*, Hart could have used a fairly short exposure -- in early September around 5:30 p.m.-- when the setting sun shown directly into the tunnel (Fig. 6).
These estimates are roughly corroborated by a statement in Van Monckhoven's book warning of the danger of overexposure due to the *great sensitivity* imparted to wet collodion negatives developed by the iron process.[95]

(Fig. 67) Alfred Hart: 1868 Senate Chamber of State Capitol.

As mentioned in footnote No. 95, his suggested exposure would also indicate a film speed of ASA 9.

STEREOGRAPH PRODUCTION

The wholesale production of stereo cards was an industry in itself. Starting in 1851 with views of the International Exposition in the Crystal Palace in London, thousands of stereographs were produced each year. In 1854, stereograph manufacturing was begun in the United States by William and Frederick Langenheim. The invention of the inexpensive Holmes-Bates viewer in 1860 and the widespread introduction of the inexpensive paper stereograph mount, greatly increased demand. During the period from 1861 to 1873 there were hundreds of stereograph producers who measured their annual volume in the thousands, although the total number produced is not available. As an example, Hart, who was a relatively small producer, sold over 7,000 stereographs to one customer, the Central Pacific Railroad, in 1869.[96]

In his early years with the CPRR Alfred Hart mainly left the finishing task to established stereo-publishing firms such as Whitney & Paradise or Lawrence & Houseworth. Other photographers often handled stereograph production in their own studios. The process could be divided into four tasks:

1. Making and masking prints from the negatives
2. Obtaining and/or imprinting the mounting cards
3. Trimming the prints and mounting them on the cards
4. Adding the titles, and usually, a series number.

MAKING STEREO PRINTS

In Hart's time, the prints were made on a thin, high quality paper, (which was often called "albumin paper"), first treated on one side with a coating of albumin (egg whites containing sodium chloride, whipped to a froth, and filtered) which gave much finer detail and a glossy surface. The glossy effect could be varied by mixing from 10 to 40 percent water with the albumin; more water yielding a duller surface.
Directly sensitized, or "salt paper" (without albumin) was not used for stereos, but recommended for portraits and some

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no longer exists. The light level in the shadows is estimated at EV 6 as it would be set on a modern light meter. The highlights might be at EV 10. "EV" refers to "Exposure Value" and EV 1 is so dark, human eyes can only make out forms, and EV 19 is the reading when looking directly at the sun through a very thin cloud.

95. This passage was inserted by the English translator, W.H. Thornthwaite, of *A Popular Treatise on Photography* on page 65: "On a moderately bright day without sunshine, with a 2 inch [diameter] achromatic lens of 12-inch focus, and with a 1/4-inch stop (yielding a modern f/48), a first-rate negative of a landscape should be obtained, by 12 seconds' exposure." If one assumes "A moderately bright day without sunshine" (where else, but England) would provide 1,000 lumens per square foot giving a modern Pentax Spotmeter reading of EV 11 (on the brightness scale), then the modern film speed would be ASA 9.

96. Glenn Willumson, *Alfred Hart: Photographer of the Central Paciëc Railroad,*
Appendix E page, and endnote 42.

landscapes because it gave a softer image and also for very large prints because it was easier to make.

(Fig. 68) 1860s Printing Frame (Van Monckhoven).

(Fig. 69) Rack for holding print frames in sunlight.

(Fig. 70) Examining the action of light on the printing paper. Only half the back was opened so the print and negative remained in register when the back was closed for further exposure (Van Monckhoven, 1867).

LEFT: (Fig. 71) William Keith's woodcut based on Hart's No. 171 *Miller's Bluffs--Old Man Mountain in dist.* for publication in the San Francisco *California Weekly Mercury*. Keith followed Hart's view quite closely, but turned the train around and added several cars.

Judge Crocker, over Huntington's objections paid to have this series of woodcuts made, without credit to Hart, and had them published serially starting in October of 1867. Huntington was not concerned about the lack of credit to Hart, just the cost.

RIGHT: (Fig. 72) William Keith's woodcut based on Hart's No. 129 *Donner Lake, with Crested Peak and Mt. Lincoln in distance* for publication in the San Francisco *California Weekly Mercury*. Keith followed Hart's outline of the mountains closely, but altered the early morning tranquility of Hart's view by adding the overloaded rowboat in the foreground and, on the mountain, the coal-burning locomotive (smoke from wood fuel, which the CPRR used, tends to be white). The Summit Tunnel wasn't completed until 48 days after this publication date; so Keith's scene is not "from life."

Hart made his stereo prints on paper[97] about 4/1000 of an inch thick, coated for a few minutes on one side with a dilute solution of sodium chloride in albumin, and then dried. [98] Factory produced albumin paper could also be purchased commercially. Whether purchased or coated by the photographer, the albumin paper contained only salt in albumin and was not sensitive to light. It was also very fragile and had to be handled carefully by the edges. If the surface were touched by the fingers, stains in the finished print were likely to occur. The dry sheets of albumin/salt coated paper could be kept for long periods in tight, dry, tin or zinc boxes. Moisture, particularly when combined with high summer heat, resulted in the rapid deterioration of the albumin.

97. Some samples of Hart's photographic printing paper measured .0035-inch thick including the attached albumin surface; for comparison an average human hair is about .003-inch, and modern glossy color prints are .010-inch in thickness. His paper was probably a little thicker at first, as it had been compressed, first in the printing frame, and later in the mounting press used in attaching the print to the card.

98. The smaller sized sheets of albumin paper used by Hart for stereograph prints (usually 8" x 10" to be cut in half, or 5" x 8" for direct use) were dried by hanging from wooden clothespins with small glasses to catch the excess solution at the lower corners of the paper. Large sheets for mammoth prints required much more attention and were often dried pinned to an inclined surface covered with blotting paper. The same drying methods for the respective sizes were repeated for the sensitized sheets mentioned later, except they had to dry in darkness.

SENSITIZING THE PAPER AND PRINTING THE NEGATIVE

Working in deep yellow or yellow light, the printing paper was sensitized by floating it for three or four minutes on a bath of 80% water and 20% silver nitrate with about 2.5% *Kaolin* added to maintain clarity. Without this latter substance, a deep yellow tint would rapidly develop which would create an unpleasant color in the final print.[99] Up to 150 sheets of paper 5 by 8 inches could be sensitized in 24 ounces of this solution. The paper was again dried by hanging as described in the previous footnote. The dry sensitized sheets had to be stored in darkness and used within 48 hours unless specially preserved.[100]

In Hart's day, printing on the relatively insensitive silver chloride

99. Kaolin, named after a mountain in north China where it was first obtained, is a fine white clay produced by the decomposition of feldspar and is mainly used in the production of porcelain. It is also available in the U.S. from the decomposed feldspar produced from granite.

100. The dry sensitized albumin paper could be stored for a period of months in an air tight, zinc or tin box furnished with a porous false bottom, above which the sensitized paper was placed, and below, a dish of desiccated calcium chloride. After opening this box a few times to use paper, the calcium chloride had to be removed, thoroughly dried in a low oven, and returned to the box.

paper required a prolonged exposure to direct sunlight. The long exposures were necessary because no subsequent chemical development of the latent image was employed, and the action of light alone broke the silver/chlorine bonds and deposited the metallic silver of the image.[101] The exposures, often measured in hours, required a substantial investment in print frames and copy negatives (mentioned in footnote 56) for quantity production, but gave the photographer ample time to monitor the progress of exposure and to fix and tone prints while others were still being exposed.

To make the exposure, the necessary materials were arranged in the inverted printing frame [102] in the following order (starting with the plate glass in the print frame which would be turned to the sun):

1. The heavy glass of the print frame.
2. An opaque mask of black paper or other thin material to obscure unwanted portions of the negative.
3. The negative with the plain glass side in contact with the mask and the collodion side to the rear.
4. The sensitized printing paper with sensitive side toward the collodion side of the negative.
5. The wood, hinged back of the print frame with the felt side on the back of the printing paper.

This operation was conducted in yellow light to protect the sensitive paper. The print frame was then tightly closed, taken outdoors and turned so as to expose the plate glass side to direct sunlight. Contact printing frames sold today are almost identical with those used in Hart's day, including the hinged back needed to hold one end of the paper tight against the negative while the other end was opened in subdued light to allow inspection of the emerging image (Fig. 68). The darker portions of the print (under the lighter areas of the negative) passed successively through the following colors as exposure progressed:

1. Very pale blue
2. Pale blue
3. Clear Bluish Purple
4. Deep purple
5. Black
6. Metallic grayish black
7. Olive, or greenish bronze

The progress of the exposure could be examined by opening one half of the print frame as shown in the illustration taken from Van Monckhoven's book (Fig 70). It was important that the print should appear darker than seemed necessary because of the fading which occurred in subsequent treatment. Experience and a well-honed judgement were needed to determine the exact moment the exposure ended, particularly as the print would undergo some fading in both the fixing and toning baths. Even when exposed until a black image appeared, the final print would have a brown color after fixing.[103]

After being exposed, the prints were thoroughly washed in plain water to remove the free silver nitrate, gold toned, washed, fixed in hyposulfite of soda, washed again, and dried. Many of Hart's surviving prints are overly dark, indicating insufficient fixing in the hypo or more likely, overexposure in printing. This could have occurred because he meant to gold tone the prints (which made them fade somewhat) but then skipped that step. The fault was not in Hart's negatives because when Watkins later printed the same

101. The use of more rapid printing paper for artificial light or on rainy days was well understood, but little used because it required the paper be slightly damp during exposure. As a result only light pressure between the paper and the negative could be used as the negative could be easily damaged. The more rapid paper was first treated with potassium iodide, dried, sensitized for one minute by floating it on a solution of silver nitrate and acetic acid, and dried between blotters. It was then (while still damp) lightly pressed against the negative, exposed for 5 to 15 seconds to daylight, placed with its back to a sheet of glass, and the latent image rapidly developed in a gallic acid solution.

102. For the modern reader, more familiar with enlarging rather than contact printing, Van Monckhoven's description of the printing frame is included here: "The instrument consists of a simple wooden frame, at the bottom of which is a strong piece of plate glass, which should always be cleaned on both sides before using. The negative is placed on the glass with the plain side downwards, while the sensitized side of the paper is brought into contact with the collodion film, which is, of course, uppermost. In order to maintain perfect contact between the sensitized paper and the negative, the printing frame is furnished with a hinged board lined with cloth or felt, and kept in its place with transverse bars with springs or screws."

103. Modern enlarging paper containing silver bromides is far more sensitive to light than the silver chloride paper described in the text, but even after three hours in the direct sun, the enlarging paper only turns deep purple. After fixing in modern fixer (Hypo and a hardener), the image is a pale rose color. For the results of making prints by methods from Hart's time, see the last page of Appendix F.

negatives, dark prints did not result.

MASKING

The stereo negative as exposed in the camera measured 5 by 8 inches and contained two images each about 4-3/4 by 3-3/4 inches. The final contact prints Hart attached to his published stereographs were about 3 inches square, with square corners (some used a dome-topped shape, possibly to eliminate dark upper corners)

Although he could have printed the entire negative, and then carefully trimmed each image to the required size, the difficulties involved for a large production run are obvious. It was much more sensible to make a mask of a piece of black paper 5 by 8 inches and cut out two holes 3 inches square, place it in front of the negative, [104] and thus make prints with the images consistently showing the desired portions of the negative and always of the same size.[105]

Control over four factors important in stereo card production resulted from printing a portion of each image on the negative to set sizes controlled by two rectangular openings in a mask covering the whole negative. First the separation of the two openings in the mask determined the optical spacing [106] and thus the type of viewer required to bring the finished images into visual coincidence allowing the eyes to effectively see "depth". By the time Hart was making stereographs, manufacturers of stereoscopes or viewers in the United States had already standardized on prismatic lenses that allowed a person with normal vision to merge views with an optical spacing ranging from 2-1/2 to 3-3/8 inches.

With these viewers, optical spacings of 1/8 inch either side of 3 inches were the *easiest* to view. It appears Hart's negatives (and thus his taking lenses) had an optical spacing of about 3-1/4" which he reduced to 3 inches, or a bit less, by adjusting the printing masks.[107] An exception to this optical spacing occurs in most of the stereographs which he published with the back imprint "for the CENTRAL PACIFIC RAILROAD COMPANY." These had reduced optical spacing, possibly to include additional coverage at the edges of the images,[108] or to permit the use of simpler viewing devices. In a random selection of 12 such stereo cards the optical spacing varied from 2-1/2 to 3-1/8 inches and averaged 2-3/4 inches.

In addition to the standard viewers, many other sizes were produced for a wide variety of optical separations. One of the more unusual, being a tiny German "Taschen Stereoskop" model for 1 by 1 inch images with an optical separation of 1-3/4 inches and lenses adjusted to *increase* the separation to that of normal human eyes

(Fig. 73) Hart No. 199 masked to give optical spacing of only 2". Hart may have made it for free-viewing or a special viewer.

104. The mask was placed in front of the glass negative on its plain side to avoid any separation between the collodion image and the printing paper.

105. Although only a few examples have survived from before 1890, transposed glass copy stereo negatives were produced in the 1890s and later, with the two images trimmed to the correct size, cut apart, and transposed. These were then correctly oriented and attached to a full size (usually 5" x 7") sheet of glass ready for simultaneous contact printing of both images of a stereograph. Such negatives became particularly important when thousands of copies of the same stereograph were published by. for example, the Keystone Company of Meadville, Pennsylvania. Stereographs produced by this process can easily be detected by feel or visual inspection because there is no gap between the photographic images. The two images are printed on a single sheet of sensitized paper. Unfortunately much earlier "pirated" stereographs, made from a new negative obtained by unauthorized copying of a published stereograph, were also often printed on a single sheet of sensitized paper. (See more about transposing in Appendix F, p. 204.)

Other large publishers like H.C. White and Underwood & Underwood were still attaching separate prints to their stereograph mounts as late as 1906. Peter Palmquist wrote an article for *Stereo World* in which he mentions a Lawrence and Houseworth negative (1860s) cut and mounted for direct printing.

Early un-transposed copy negatives are more common, perhaps because they were more durable than cut and remounted negatives, and cutting the prints was a more common practice then.

106. Optical spacing here means the separation on the stereograph of identical subjects in the two images. See also longer description starting near the end of page 73.

107. A few of the prints from Hart stereo negatives at the Society of California Pioneers library are of both images, and are not transposed. That is they were made directly from the stereo negative. The separation of the lenses can be closely estimated from these.

108. If the size of the finished prints are held constant, as one reduces the optical spacing by moving the holes in the mask further apart, more of the negative is included at the right and left edges. When such images are merged in a standard stereo viewer, the three dimensional portion is narrower and bordered by ghost images of the edges.

The second factor controlled in masking was that any tilting of the camera at the time of exposure (not a common problem) could be corrected. Third, the size of the prints could be adjusted for regular, cabinet, or even small European formats by means of appropriately sized openings.[109] Fourth, the openings in the mask could be positioned to print the parts of the negative yielding the most interesting information.
In this last consideration, Hart seemed to feel that the tops of distant mountains should always be included to establish a skyline, or at the least the upper part of the negative was as important as the foreground. An example of this can be seen in Appendix A: Hart No.123: *Lakeview Bluff*, taken from the Dutch Flat and Donner Lake wagon road before the tunnels were finished.
Hart's published view shows all of the rock above tunnel 8 and most of the tree at the left, but nothing of the road. From the un-cropped print at the Society of California Pioneers one can see that the deeply rutted wagon road at the bottom was included in Hart's original negative. The road is historically significant and illustrates man's effort to conquer the difficulties of that area. Watkins seemed to agree because when he published this view from Hart's identical negative, his masking showed a portion of the road and cut off at the exact top of the rock.

TONING AND FIXING THE PRINTS

Exposed prints were stored in a tightly closed box with calcium chloride until there were enough on hand for efficient processing. In yellow light ten to fifteen prints at a time were immersed in a water bath for 10 minutes to remove the silver nitrate not affected by the exposure. Since it was very easy to stain the albumin surface, handling was done with wood or bone forceps.
The prints were then transferred separately to the toning bath, a solution of gold chloride, bicarbonate of soda, and a pinch of common salt. The prints first turned red and then gradually shifted in color to black and then bluish black.. Toning could be stopped at any point by placing the print in plain water.[110] After washing, the prints were then immersed in the fixing bath of hyposulfite of soda for 10 to 15 minutes.

They were next rinsed in a water bath and then soaked for two hours in one water bath followed by three hours in another. If running water were available the five hours in the last two baths could be reduced to 10 or 15 minutes.[111]
After being dried, the prints were ready for trimming and mounting. Because the printing mask was separated from the collodion image by the thickness of the negative glass (usually 1/16" inch), and the sun moved during the long exposure, a slightly fuzzy edge resulted.[112] Hart trimmed off the blurred edges of his prints to a square shape using shears or a paper cutter. Some other photographers prepared dome topped prints or other shapes using steel or glass guides and a sharp knife. Others also produced "deluxe" albumin prints and would finish the mounted print by covering it with a thin layer of very clear

109. Each of the two images on the usual American stereograph was about 3"x 3", Cabinet stereograph images were about 3" wide by 3-5/8" to 4" high and the European images from a 4.5 x 10.7 cm. plate were 1-5/8" x 1-5/8" and from the 6 x 13 cm. plate, 2-3/8" x 2-3/8".

110. Experience was important in selecting the proper color at which to halt the toning process. Blue-black usually changed to black in the fixing bath and colors before blue- black yielded a brown or sepia tone after fixing. Inspection in the toning bath was affected by the natural gold color of the solution and the yellow light of the darkroom. If left too long in the toner, the prints lost contrast after fixing.

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hen a black tone was wanted, the prints had to be exposed longer in the printing frame than for purple or sepia tones, because the toner had a bleaching action.

111. Then, as in 1994, if a print was insufficiently washed in the final bath it contained hyposulfite of soda. When dry,it had a sweet taste, and faded in a short time. Take the taste information on faith--I checked it out and found it to be true, but a little nauseating.

112. This same effect required that writing on the negative -- which was intended to show clearly on the print -- had to be done on the emulsion side from right to left and each letter had to be reversed. Modern photographers working with thin films and the unmoving parallel light of an enlarger, or an artificial source, can write un-reversed on the back of the negative.

Darkroom technicians of the glass-plate-era sometimes were amazingly skilled in reverse writing, but some photographers doing their own labelling seemed to often forget to reverse certain letters, "S" being a particular problem.

varnish, and after drying, roll it through a polished steel roller to give it a high gloss. However, examination of Hart's stereographs under a low-power microscope suggest that he did not varnish his prints.

By the 1860s American stereographs were fairly well standardized at 6-3/4 to 7 inches long and 3-1/4 to 3-5/8 inches wide. Width varied upward for some makers (but not Hart) to a 4-1/4 inch "cabinet card" size. Hart was quite consistent in the size of his individual finished images (the two prints glued on a card mount), and in checking a random selection of a dozen prints, sizes varied only slightly from 2-15/16" to 3-1/8" high and 3" to 3-1/16" wide. While an occasional Hart card mount is larger, the great majority were 6-3/4 x 3-1/4 inches. Normal stereoscopes or viewers, described on pages 105-108 had mounting frames for the 7 inch length, limiting publishers to that length or a little less. As occurred frequently with stereographs published in the 1860s, the fronts of Hart card mounts bore printed "series" notations on the left end of the card like, "Central Pacific Railroad" or "Hydraulic Mining," and the state or region in which the view was taken appeared on the right end. The backs of Hart's card mounts were imprinted with his logotype including his name and other information. Copies of all of his back imprints known to this writer(and Hart had far more than any other publisher}, are in Appendix A (pp. 140-146).

TRANSPOSING

In mounting the images on the card, it was essential that the print taken with the left lens be placed on the left (and the right one on the right). If this rule were not followed, the true depth effect was lost and frequently objects further from the camera actually appeared closer. Because of details of the image-forming process occurring in stereo cameras, it was necessary to transpose or interchange the left and right print images made from the full stereo negative.[113] This was accomplished by the simple process of making separate prints or making a print of the full negative and cutting it into two. The resulting positive images were then glued [114] to a mount card in the opposite positions they occupied in the print frame.

This process resulted in the exchanging of the left and right images and was called "transposing." If the photographic printer fails to mark the left or right images of a stereo pair, or if they somehow get mixed up before being attached to the card, identification of the left and right image must be done by looking closely at the views themselves. Unfortunately there is nothing like "perfect pitch" in left/right stereo images. If only a single image is available there is no way to tell if its a left or a right, but if both images are available and in them close objects are visible against a more distant background, identification is easy. With the two images attached, one measures the optical spacing of foreground and background objects. If the foreground optical spacing is smaller than the background spacing, the prints are correctly oriented and the left print belongs on the left. When the foreground spacing is larger (as in Fig. 59, p.91), the left image is on the right and transposing is required for stereo viewing.

For pairs of loose or unmounted prints, the foreground is shifted to the left in the right image and vice versa in the left one. Occasionally a tiny "x" was marked on the negative at the

113. Taking quinine to cure malaria or eating fresh vegetables to cure scurvy are examples of simple solutions to rather complex problems. In the same way, the concept of transposing is simple but the explanation of the optical problems requiring it can be rather tedious. For the reader interested in the optical need for transposing of stereo images, more details are found in Appendix F, p. 204.

114. Hart was careful to use non acidic paste in mounting his stereo prints, as it is very rare to see glue stains in the stereographs he made. In Van Monckhoven's words, "Nothing but *recently prepared* starch-paste should be used, and the proof (print) should be allowed to dry very rapidly when mounted in order that no acid principles may be developed by fermentation."--page 117. On the other hand, Watkins' prints often show glue streaks which are particularly noticeable in the sky areas. This problem appears to have affected Watkins' prints during a particular period when he had obtained a different source for his glue, and he may have been using unskilled technicians.

outside lower corners, these marks appeared next to each other at the bottom center on a proof print after transposition. They were normally trimmed off and were not visible on the finished stereograph.
Hart, and many of his contemporaries, provided another identifying feature which helped determine the left and right images of a stereo set. Hart almost always printed a bit more of the left side of the scene in the left image and more of the right side in the right one. This was done in the masking process and probably to adjust optical spacing.

TITLE STRIPS

Titles identifying the scenes on the Hart cards were printed in tiny 6-point type on thin yellow paper. If the title ran more than four or five words, the remainder was set in even smaller 4-point (about 1-1/2 millimeter high) type. These narrow title strips (varying from 1/8 to 3/16 inches wide) were then cut from a larger sheet and glued below the image on the right. For the lucky person assigned this job it would have been nice to have had one or more sheets for each one of the 364 views. Then by picking the correct sheet it would be only necessary to snip off the top label and glue it down.
Unfortunately that would have meant that the printer would have had to set a page of that eye-killing type for every view--364 settings. Instead the strip labels were printed in sequence, and about 200 could fit on an ordinary piece of typing paper. Thus, with only two setups, any number of full sets could be printed by just running more copies. The proof of Hart's use of this method can be found on his stereographs in the Library of Congress collection where a bit of the preceding or following numbered title has been left attached.
If one visualizes the finisher working by lamplight on a rush order, surrounded by partly cut-up, lace-like sheets of labels, it's certainly understandable that occasionally the wrong label was used. With a magnifying glass, evidence of this problem can be found on some of the view mounts in Appendix A.

In contrast, Watkins printed the identifying labels in about the same size type, directly on the card. He may have had the card printer do it in advance, but it would have made more sense to use a tiny hand press in his own shop. Occasionally a Watkins card will have the title too deeply impressed into the card stock or not perfectly aligned with the bottom edge. Both suggest the small hand press. Possibly because of this method, incorrect labels on Watkins views are very rare. Hart also employed direct printing on some of his late "For the Central Pacific Railroad "cards.
As an aside, because of the care and dexterity of the printers of that era who set all that tiny type by hand, one almost never sees a misspelled word in a card label. When pressed for space, they got a little imaginative with abbreviations, but seldom with spelling. In one instance
(No. 311) Hart's printer, who may have just been setting type for menus, spelled "desert" with two "s's."

VIEWING STEREOGRAPHS

When first looking at a stereo card held at normal reading distance, the eyes consider it like anything else and converge or turn slightly inward. This causes both eyes to look at the same close location and incidentally refocuses the lenses for close use. However in viewing stereo prints, the three-dimensional or depth effect occurs when the observer is able to merge the two images into one while maintaining sharp focus, either by means of an optical device called a stereoscope or unaided as in the following description of free viewing by directly viewing the stereograph without the intervention of the prismatic lenses of a stereoscope.

The turning muscles in the eyes relax (but not those that control focus) as they do when viewing a distant object, and the eyes see each image as a separate scene just as they

would if present at the camera location.
The brain then processes the information received and delivers the sense of a single view, with depth perception, as it would from nature. The process just described is called "free viewing" and because of the necessary independent functions of the directional and focussing muscles, it is easier for nearsighted eyes. Tiny stereo images the size of postage stamps can be free viewed or merged by many people without any optical assistance. Larger images with wider optical spacing are much harder to free-view although through practice or natural ability a few can do it.[115]
For the majority of people in the nineteenth century, stereographs became three-dimensional when viewed through a form of stereoscope, defined in the Oxford English Dictionary as:

"An instrument for obtaining, from two pictures of an object, taken from slightly different points of view, a single image giving the impression of solidity or relief as in ordinary vision of the object itself".

The first stereoscope was invented by Professor Charles Wheatstone (1802-1875) before 1832 and used a concave mirror to magnify and reverse the images.

115. Because of an approximately 60 percent reduction in size, the stereos in Appendix A are excellent candidates for free viewing. The reader is urged to try, and if successful, much more of the original scenes can be appreciated.

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ith aid of mirrors and/or prisms, widely separated or very large images can be brought to the eyes properly spaced for stereo viewing. The Carl Zeiss Company made a World War I stereoscopic range finder with objective lenses separated by over a meter. The lengthened light-path in such devices usually requires magnifying lenses to maintain image size and detail.

(Fig. 74) Some stereoscopes available in the 1860s. Clockwise from the left: 1. Beck viewer with Brewster type achromatic focussing lenses, for transparent or card-type stereographs. The door at the top had a mirror on its inner surface to reflect light to card views, and the door was closed for glass views. It was stored inverted in the polished wood box upon which it is placed. 2. Another Beck viewer for looking at stereos in books (original instruction sheet in front). 3. Holmes-Bates type of aluminum and wood made by Keystone View Company (Not available in the 1860s). 4. Brewster type viewer made in England. 5. Early all-wood Holmes-Bates type viewer. In the early days of stereographic photography, some books were illustrated with tipped-in stereos, the first being C. Piazzi Smyth: *Teneriffe, An Astronomer's Experiment*. (London, Lovell Reeve, 1858) which had 20 such views of exceptional quality. (MBK Photo)
(Fig. 75) Keystone View Company, Meadville, Pennsylvania 1895-1960: *General View of Mounting Department*. This was the last and the largest of the American stereographic manufacturers. Their mounts were heavy, curved cardboard. This view seems ca. 1906-1914.

Wheatstone also invented the concertina, the electric Wheatstone bridge, and the revolving mirror used for the measurement of the speed of light. Since 1832 was some seven years before the invention of photography, his first stereoscope was an optical curiosity used with carefully made pairs of drawings, but for a few years after 1839 (until Brewster's invention spread) it was used to view stereo-daguerreotypes. Wheatstone also proposed the name "stereoscope" for the device.[116]

In the early 1840's Sir David Brewster, a renowned British optical scientist, invented an improved form of the stereoscope in which a combination of simple lenses and prisms compressed the optical spacing and magnified the images. The magnifying lenses of about 8 inch focus were spaced about 2-1/2 inches apart like human eyes. The prisms, thicker at the outer edges and cemented to, or ground integrally with the lenses, bent the light rays coming from the stereograph so they emerged parallel for a short distance and 2-1/2 inches apart. This permitted ordinary eyes to merge images having an optical spacing of 3-1/4 inches on the stereograph. Brewster's invention was demonstrated at the 1851 International Exposition in London and admired by Queen Victoria.

A rather elaborate stereoscope manufactured by Smith, Beck & Beck of London before 1859 employed achromatic lenses of the Brewster type and would also have been available to view Hart's stereographs. A selection of these viewers is shown in (fig. 75). The term "stereopticon" which means a stereo projection device, like a pair of magic lanterns, is frequently used incorrectly as being synonymous with "stereoscope."

In the United States a viewer using Brewster lenses was perfected in 1860 by Oliver Wendell Holmes (1809-1894) in cooperation with Joseph Bates, a Boston photographer. It was easier to use and cheaper to make than the Brewster stereoscopes and survived almost unchanged well into the twentieth century. All these viewers were required because, with ordinary vision, optical spacing larger than 2 inches could not be merged into a single three-dimensional image, and if held to this restraint only pairs of tiny images each about 2 inches wide could be used. In addition to widening the allowable optical spacing by means of prisms, these viewers also included magnifying lenses to bring out the detail of the relatively small images.

The optical spacing[117] of the mounted images can be measured by getting the horizontal distance from an object in one image,

116. Charles Wheatstone, *Transactions of the Philosophical Society* (London: --,1838) CXXVIII p. 374. Wheatstone also described the details of his stereoscope in 1838. The account books of the philosophical instrument maker Newman of London supplied evidence that he constructed stereoscopes for Professor Wheatstone in 1832.

117. As used here, "Optical Spacing," is a measure of the divergence of the eyes in order to free view the stereograph. "Image separation" can mean the distance between the lens locations for each of a pair of stereo images. The greater the image separation the larger the apparent differences in depth in the finished stereo view. In the nineteenth century, photographs of the full moon were taken on successive nights or lunar months resulting in image separations of thousands of miles. Modern foresters and topographers make 9" x 9" aerial photographs in rapid succession from an airplane with image separations of thousands of feet. When viewed in pairs with a large optical stereo viewer, the heights of individual trees can be measured, and the terrain reduced to a relief map giving elevations.

say a flag pole or tree, to the same object in the other image. If the reader decides to check this on a stereo card, it will also be noted that this optical spacing is less for close objects than for those in a distant background.[118]

The reasons for this are further described in the opening paragraphs of Appendix F. In at least one instance, Hart tried an experiment (with No. 199: *Wagon Road and east portal of Summit Tunnel*) in which he reduced the optical spacing from the usual 3 inches to only 2 inches, possibly to permit freeviewing (Fig. 73).

LOOKING FOR THE PHOTOGRAPHER

Photographers, even those working with assistants, rarely appear in their published images. Hart was no exception, and in the entire 364-view series there are really only two or possibly three views in which he may be pictured. In No.179, *Old Man Mountain*, he may be the man standing beside the large camera at the extreme left. In No. 181, *North Fork of the South Yuba*, a man (possibly Hart) holding a sketch pad and wearing a hat with a black hat band sits at the right. He appears to be making a portrait of the man with a stiff straw hat sitting facing him, and we know Hart painted portraits in the East, long before his arrival in California. In No.169, *Yuba River Valley*, and No.170, *Cement Ridge*, the man riding behind the cab has a hat resembling one seen in earlier views, and it would make sense for Hart to be near the engineer in order to tell him when and where to stop.
The train had actually already stopped, but Hart may not have moved yet. All these observations are mere suppositions and also presume the presence of an assistant to make the exposure. The shadows cast by Hart and his camera appear in several views, always at the bottom and usually at the right: No. 13, *View in Bloomer Cut*, shows the shadow of large camera with a dark cloth over it.

No. 141, *Tangent below Pino*, taken near present-day Loomis, California, in the afternoon from the top of a rail car shows Hart's shadow in a long coat and the camera seems the same size as the one in No. 13. No. 224, *First Crossing of Truckee River*, (Fig. 76) also shows Hart's shadow, and that of a camera with a dark cloth over it.
No. 224, in addition includes a dog (Hart's?) with dark ears and of the same size as the one in No. 179, *Old Man Mountain*.[119] Another example, No. 225, *Bridge over ërst Crossing* (Fig. 39) has the shadow at bottom center and it is clear the camera is small, with light, wishbone-like legs on the tripod. Motion can be seen in Hart's shadow at the right, possibly as he moved the dark cloth or lens caps to make the exposure. In this instance, the tripod legs come all the way to the bottom of the camera, unlike the tripod in Nos. 179 and 188 (a) (Figs. 64 & 65) which has short legs and a long, heavy, vertical shaft. In Fig. 27 taken by A. J. Russell at Promontory, Hart is shown on top of a distant locomotive with his smaller camera and the light tripod.
Collectors of vintage photographs will quickly recognize the problem of naming unidentified people. For instance, in many Eastern views every tall man in a top hat is identified as "possibly Abraham Lincoln." In Hart views, modern pencil (or even red ball-point pen) notations on the back of the cards

118. The differences in optical spacing between objects in the foreground and those in the background can help curators and collectors in identifying uncut and untransposed negatives as they came from the camera. This information is important because many large collections, and particularly those from amateur stereo photographers, occasionally contain untransposed stereo print pairs. These pairs are often of unpublished negatives or of unused variations of a scene within a set of the same subject.

119. The presence of the dog is mentioned because it is probably the same one in Hart No. 179 and No. 224 (Appendix A). In both scenes, the dog is looking at the camera operator. In No. 224, there is little doubt that the cameraman is Hart. This tends to support the supposition that the man with his hand on the camera at the extreme left of No. 179 is also Alfred Hart. The dog may well have belonged to Hart, or at least travelled a lot and displayed an interest in cameras.

identify most tall solemn-looking men as "Strobridge," heavy set ones as "Leland Stanford," and any others not obviously Chinese or North American Indian as "possibly Hart". Lets hope they're all correct.

(Fig. 76) Portion of Hart No. 224 *First Crossing of the Truckee*, with Hart's dog at lower left and his shadow at lower right. (From Society of California Pioneers full-size print). More detail is shown here at the right and bottom than appears in a normal stereo view.

(Fig. 77) Portion of Hart No. 181 showing Artist (Hart in wide-brimmed hat ?) sketching a portrait of bearded man.

(Fig. 78) West end of Donner Summit Tunnel looking east at about 6:30 p.m. in September 1994. The rails have been removed, but the ties remain. The stone overhead is jet-black from 130 years of wood, oil and diesel smoke. (MBK photo)

HART'S NON-RAILROAD PHOTOGRAPHS

In addition to the Central Pacific series, Alfred Hart produced other stereo views of Sacramento and its waterfront, interiors of homes and Pullman cars, scenes in San Francisco, views of giant Sequoia Redwoods, of Yosemite, and many other California locations. The Sacramento Archives and Museum Collection Center has an album presented by Hart to Mrs. Theodore D. Judah containing a large (8-1/2 by 6-1/2 inches) Hart image of Mount Diablo. Two or three non-railroad carte-de-visite images with Hart's back imprint are known to this writer.

Of Hart's non-railroad stereographs, few have printed titles and even fewer are numbered, making a systematic classification and dating of these images very difficult. As an indication of their overall appearance, eight of the non-railroad Hart stereographs are included following the CPRR series in Appendix A. An idea of the existing number of these mostly untitled, non-railroad, stereographs on Hart mounts may be gained by noting how many are in some collections where they have been listed separately. One private collection has 41, the Crocker Art Museum has 12 and the California State Railroad Museum at Sacramento has four. Among all these are at least four duplications, and four or more are identical to views published by Houseworth. Hart may have intended to publish other sets because a few Hart titled views exist with numbers above 364, some examples being; one of Yosemite Falls numbered 1008, one of Upper Cisco in winter numbered 491, and one of the levee at Sacramento from the deck of the steamer CAPITOL numbered 838.
It is hoped that further information on these non- railroad views may be published at a later date.

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APPENDIX A

Reproductions

of

Alfred Hart's CPRR Stereo Views

APPENDIX A

Notes on Hart's Stereographs

1. As mentioned earlier, the assistance of two people was vital to the preparation of this appendix. Jeneane Crawford selected the stereographs to be photographed on sheets of 12 views, checked the order and titles and carefully prepared and inserted replacement photographs on the master sheets. Barry Swackhamer brought his collection to Sacramento, provided improved or unavailable copies for photographing, and checked titles. Without them, this section would never have been completed.

2. Due to the rarity and age of the stereographs reproduced, it was very difficult to produce copy prints of equal density and contrast. Some had holes in the corners from being tacked to a wall, a few had only one usable image which had to be

duplicated to simulate a stereograph, and many had faded over the years requiring an enhancement of lost contrast.

3. Most of the stereographs reproduced here were obtained from the two private collections listed in Appendix D. Those from public collections are marked with an asterisk in Appendix D. As often as possible a stereograph published by Hart was reproduced, but a markedly superior Watkins-published card was occasionally used.

4. The prints are arranged in the numerical order assigned by Hart, that is, by the numbers preceding the titles. When the title on the card is absent or incorrect, the illustration is placed in position as if numbered and titled correctly.

5. The titles given below each card are not always those used by Hart, but include information to assist in identifying the location or call attention to a detail of the stereograph not readily apparent. For the exact Hart title, refer to Appendix B which also has further descriptive information in the footnotes. To obtain the Hart numbers of all titles at a given distance from Sacramento, use Appendix C.

6. By error, one print (Hart No. 56) occurs on both pages 120 and 121, fortunately it's one of his best. 25 prints are variations of Hart titles. As far as possible the version included in the Leland Stanford Album at the Green Library of Stanford University is listed as the "regular" issue. If not included in the Album, the version most frequently seen is considered "regular"
A few untitled Hart variations which seem to have been taken near the railroad are located at the end of the regular numbered series. If these are near an existing regular view, they are given the number of the view followed by a letter. If they are not related to a particular regular view, they are numbered starting at 1000.

7. Reproductions of 19 imprints from the backs of stereographs published by Hart, one carte de visite he published, and three imprints used by Frank Durgan are included at the end of Appendix A. They are arranged alphabetically and designated by the letters A through W. Back imprints having the same words and different styles are arranged chronologically.

Alphabetical Listing of Hart and Durgan back imprints

Illustrations of back imprints are in the order listed on pages 149-151
The notes in brackets have been added for using this list without the ilustrations.

A. Alfred A. Hart, ARTIST Sacramento [no address]

AA. The World as seen in CALIFORNIA [135 J Street]

B. The World as seen in CALIFORNIA [no address]

C. CALIFORNIA Photographed and Published by
Alfred A. Hart

D. For CENTRAL PACIFIC RAILROAD [plain border]

E. For CENTRAL PACIFIC RAILROAD [ornate border]

F. Sierra Nevada Frank DURGAN [65 J, Small locomotive]

G. Sierra Nevada Frank DURGAN [65 J, Large locomotive]

H. F. DURGAN, Lewiston [Maine] [rubber stamp]

I. Scenes on the HUMBOLDT RIVER [135 J address]

J. Scenes on the HUMBOLDT RIVER [Golden State 65 J,

shaded letters.]

K. Scenes on the HUMBOLDT RIVER [Golden State 65 St., plain letters.]

L. Scenes in the Valley of the SACRAMENTO [135 J Street]

M. Valley of the SACRAMENTO [Golden State Gallery 65 J St.]

N. Scenes near Great SALT Lake [Golden State Gallery, shaded letters]

O. Scenes in the SIERRA Nevada Mountains, 135 J St.[paste on label]

P. Scenes in the SIERRA Nevada Mountains, [no street address]

Q. Scenes in the SIERRA Nevada Mountains, [135 J St. address]

R. Scenes in the SIERRA Nevada Mountains, [Golden State Gallery 65 J Street]

S. Scenes in the SIERRA Nevada Mountains, [65 J St., Ornate border, like Durgan]

T. Scenes in the WASHOE RANGE [135 J address]

U. Scenes in the WASHOE RANGE [Golden State Gallery, 65 J Street]

V. WHITNEY & PARADISE [Paste-on label "Negatives by A.A. Hart"]

W. Alfred A. Hart, Artist [back for carte de visite]

ABOVE: (Fig. 79) April 22, 1995. Exterior of Donner Summit snowshed after a hard winter. The 30-foot high interior is shown in (Fig. 47). Seasonal snowfall was over 600 inches, and some has melted, but the skier standing at track-level could still cross right over the shed. The CPRR worked 24 hours a day on the adjacent tunnel throughout the winter of 1866/67 when the snowfall was similar. (MBK photo using 1000 m/m telephoto)

RIGHT: (Fig. 80) April 22, 1995, Looking southeast at Donner Summit Tunnels 7 and 8. Twelve to fifteen feet of snow remained on level ground as it did in 1867 when the CPRR workers were finishing the Great Wall and the tunnels. The dark square at the center below Crested Peak is the west end of Tunnel 7. (MBK photo)

APPENDIX B

NUMERICAL LIST

OF

ALFRED HART'S CPRR STEREO VIEWS

NUMERICAL LIST OF CPRR STEREO VIEWS
BY ALFRED HART

The titles are those used on the original cards published by Hart and checked against the album of Hart photographs in the Green Library at Stanford University, or the cards themselves. *Spelling and punctuation are repeated exactly*, except that words in brackets are the author's. "Miles" indicates distance from Front Street, Sacramento.(".0" after mile figure means estimated distance)

Hart No.	Miles	Title	Notes
1.	31	Locomotive "Gov. Stanford", No.1	
2.	31	Trestle at Newcastle	
3.	31	Depot and Trestle, at Newcastle [Lady at left]	
4.	31.5	Road above Newcastle, Placer County	
5.	32	Railroad in Dutch Ravine, looking West	
6.	32	View in Dutch Ravine, 32 miles from Sacramento	
7.	32	Embankment in Dutch Ravine, above Newcastle	
8.	33	Approaching Bloomer Cut, from the West	
9.	33	Bloomer Cut, 800 feet long, looking East	
10.	33	Bloomer Cut, bird'seye view, 63 feet deep, 800 long.	
11.	33	Bloomer Cut and Embankment, looking East.	
12.	33	Bloomer Cut, 63 feet high, looking West.	
13.	33	View in Bloomer Cut, near Auburn.	
14.	33	In Bloomer Cut.	
15.	34	Embankment 60 feet high in Buckeye Ravine.	
16.	34.5	Cut West of Auburn.	
17.	35	Rock Ravine, near Auburn.	
18.	35	High Embankment, near Auburn.	
19.	35	Trestle opposite Auburn.	
20.	35.5	Cut near Auburn Station, Placer County.	
21.	35.5	Trains at Station, Auburn.	
22.	36	Road East of Station, at Auburn.	
23.	38	Road in Auburn Ravine, Placer County.	
24.	37.0	Lime Point above Auburn.	
25.	38	High Embankment, Auburn Ravine.	
26.	39	Auburn Ravine.	
27.	40	Trestle near Lovell's Ranch, 40 miles from Sacramento.	
28.	40	Road and Trestle, near Lovell's Ranch.	
29.	42	Trestle in Clipper Ravine, near Clipper Gap.	
30.	42	Trestle Bridge, 120 feet high, 600 feet long, Clipper Ravine.	
31.	42	Trestle Bridge, Clipper Ravine, near view.	
32.	43	View above Clipper Gap, Placer County.	
33.	55	Locomotive Nevada at Colfax. 55 miles	
34.	55	Locomotive Atlantic at Colfax, Placer County.	
35.	55	Depot at Colfax. 500 feet long. 55 miles from Sacramento.	
36.	55	Colfax from the South, Altitude 2,448 feet.	
37.	55	Teamster's Camp at Colfax, Placer County.	
38.	56	Canyon of Amer. river from West--Cape Horn and RR on left.	

Hart No.	Miles	Title	Notes
39.	56	Long Ravine Bridge, from top of Cape Horn.	
40.	56	Long Ravine Bridge from the west. 56 miles	

from Sacramento.

41. 56 Long Ravine Bridge-near view [from west end]
42. 56 Long Ravine Bridge from below, 120 feet high.
43. 56 Cape Horn and Railroad from the West. Height above ravine 1,400 feet.
44. 57 Amer. R. and canyon from Cape Horn-river below R.R 1400 feet. 57 miles from Sacramento.
45. 59 Sawmill and Cut east of Cape Horn. 59 miles from Sacramento
46. 61 Deep Cut at Trail Ridge. Length 1000 feet.
47. 62 Secrettown, 62 miles from Sacramento, elevation 3000 feet.
48. 62 Secrettown Trestle, from the West. Length 1,100 feet.
49. 62 Secrettown Trestle, from the East. Height 90 feet.
50. 63 Tunnel Hill Cut. Depth 111 feet. 63 miles from Sac'to
51. 63.5 Bear River Valley-You Bet and mines in the distance.
52. 63.5 Bear River Valley-Little York mines in the distance.
53. 64 Cut through "Dixie Spur"
54. 65 Gold Run and Railroad Cut. Altitude 3245 feet.

Hart

No.	Miles	Title	Notes

55. 65 Railroad and Flume at Gold Run.
56. 57 Rounding Cape Horn. Road to Iowa Hill from the river, in the distance.
57. 58 Excursion Train at Cape Horn. 3 miles above Colfax.
58. 61 Secret Ravine, Iowa Hill in the distance. 61 miles from Sacramento.
59. 64.5 Hornet Hill Cut, west of Gold Run. 50 feet deep.
60. 64 Train in Dixie Cut.
61. 65 Hydraulic Mining at Gold Run, Placer County.
62. 66 Embankment below Dutch Flat, Placer County.
63. 67 Dutch Flat. Placer County. 67 miles from Sacramento.
64. 67 Dutch Flat Station. 67 miles from Sacramento. Altitude 3,416 feet.
65. 67.5 View near Dutch Flat.
66. 68 Sandstone Cut near Alta.
67. 69 Alta from the South. Altitude 3,350 feet.[120]

Hart

No.	Miles	Title	Notes

68. 69 Alta from the North. 69 Miles.
69. 69 The Huntington at Alta. [Locomotive]
70. 69.5 Blasting at Chalk Bluffs above Alta. Cut 60 feet deep.
71. 70 Building Bank across Canon Creek. 87 feet high.
72. 70.5 Culvert at Canyon Creek. 185 feet long-12 feet span.
73. 69.3 Cut above Alta.

120. Hart No. 67. In the matter of directions, Hart generally used "West" as meaning closer to Sacramento, and occasionally "South" as the railroad tended to progress in a north easterly direction from Sacramento to Truckee. In rare instances, such as this one, he was incorrect because just before Alta the railroad curves about 110 degrees to the right and is actually going southeast as it heads toward the Summit. (He should have used "from the West.") The Cape Horn and Blue Canyon areas have problems like this as the track curves over 180 degrees in both places. The words "above" and "below" are to be taken literally. "Above" means "east of" when west of the Summit and "west of" to the east of the Summit. In spelling matters, Hart usually spelled "canyon" in the usual way. When he tried the Spanish "canon" as in No.71, his printer appeared not to have had a typefont with Spanish accents. When Watkins later issued the Hart views (with no credit to Hart), he usually used "cañon" and separated Hart's "Secrettown" to "Secret Town."

74. 62 Secrettown Bridge, 1,100 feet long. 62 miles from Sacramento.
75. 69 Superintendent Strobridge and Family, at Alta.
76. 72 Giant's Gap, American River, 2,500 feet perpendicular 72 miles from Sacramento.
77. 72 Green Valley and Giant's Gap. American River. 1500 feet below Railroad.
78. 71 Green Bluffs, 1,500 feet above American River. 71 miles from Sacramento.
79. 75 View west of Prospect Hill. 75 miles from Sacramento.
80. 75 Prospect Hill from Camp 21. 75 miles from Sacramento.
81. 74 Little Blue Canyon. 74 miles from Sacramento.
82. 75 Prospect Hill Cut. Upper slope 170 feet.
83. 75 Prospect Hill Cut. from the north.
84. 75 View at China Ranch. 75 miles from Sacramento.
85. 76 Fort Point Cut. 70 feet, 600 feet long.

Hart
No. Miles Title Notes

86. 76 View North of Fort Point. 76 miles from Sacramento.
87. 77 Horse Ravine. 77 miles from Sacramento.
88. 77 Horse Ravine Wall and Grizzly Hill Tunnel. 77 miles from Sacramento.
89. 77 Grizzly Hill Tunnel from the North. 500 feet long.
90. 80 Bank and Cut at Sailor's Spur. 80 miles from Sacramento.
91. 80 Owl Gap Cut. 900 feet long, 45 feet deep.
92. 82 Heath's Ravine Bank. 82 feet high. 82 miles from Sacramento.
93. 91 Black Butte and Crystal Lake. 91 miles from Sacramento.
94. 91 Crystal Lake. Altitude 5907 feet.
95. 90 Crystal Lake House. 90 miles from Sacramento.
96. 91 Cascades on the Yuba River, near Crystal Lake.
97. 91 Rattlesnake Mountain and Cascades on the Yuba River near Cisco.
98. 92 Black Butte from the North.
99. 92 Lower Cisco, Placer County, 92 miles from Sacramento.
100. 92 Yuba Cascade and Hieroglyphic Rocks, on the Yuba River, near Crystal Lake.[121]

Hart
No. Miles Title Notes

101. 92 Pictured Rocks on the Yuba River, near Crystal Lake.
102. 92 Hieroglyphic Rocks.
103. 92 Pictured Rocks.
104. 93 Yuba River, above Cisco, Placer County.
105. 96 New Hampshire Rocks on Yuba River, Summer View. 96 miles from Sacramento.
106. 96 New Hampshire Rocks on Yuba River, Summer View. 96 miles from Sacramento. [same as No. 105, but closer]
107. 96 New Hampshire Rocks looking down the river.
108. 96 Scene on Yuba River, above Cisco.
109. 100 Summit Valley, Altitude 6,960 feet. Emigrant Mt. and R.R. Pass in dist.["for CPRR" card says "from Lava Bluff"]
110. 100 Castle Peak from Lava Bluff. 11,000 feet above sea.

121. Hart No.102: Hart also issued a series of stereographs with the following notation on the verso (back): "Photographed and Published for the Central Pacific Railroad Company." These stereo views have different and usually shorter titles than the regularly issued cards. For instance, No. 100 in this series has the title: "Yuba Cascade and Pictured Rocks."

111. 102 Castle Peak and Yuba River, from Summit Valley. 102 miles from Sacramento.
112. 105 Scene near Donner Pass, Table Peak in the distance.
113. 105 Castle Peak from Grant's Peak.
114. 105 Scene at Lake Angela. Altitude 7,300 feet.
115. 105 Lake Angela, Mount King in the distance. Western Summit.
116. 105 Camp near Summit Tunnel-Mt. King in the distance.
117. 105 Bluffs in Donner Pass, Western Summit, 500 feet high. Altitude of Pass 7090 feet.

Hart
No. Miles Title Notes

118. 105 Summit Tunnel-Eastern Portal. Length 1660 feet.
119. 105 Laborers and Rocks near opening of Summit Tunnel.
120. 105 Scene near Summit Tunnel. Eastern Slope of Western Summit.[122]
121. 105 Grant's Peak and Palisade Rocks-From Summit.
122. 105.5 Palisade Rocks with Road and Teams descending Western Summit.
123. 105.5 Lakeview Bluff. 350 feet high. From the wagon road.

122. Hart No.120 is of interest because it shows the heavy commercial traffic using the Dutch Flat and Donner Lake Wagon Road carrying freight to both the railroad construction crews and the mines of the Comstock Lode. This photograph was probably taken in the summer of 1866 as the wagon at the center is a water wagon spraying the road to keep down the dust, and the fill between tunnels 6 and 7 appears incomplete. At that time, the railhead was at Alta about 35 miles to the west. The small dark covered wagon without a driver at the lower left is probably Hart's traveling photo wagon. The large warehouse at the center is mentioned in Gillis' report.

Hart's No. 121 is taken approximately toward the camera location in No. 120 from the top of the large rock at the center left of No. 120.

124. 106 Road and Rocks at foot of Crested Peak, Eastern Slope of Western Summit.
125. 105 Donner Lake from Summit, Lakeview Bluff on the right.
126. 105 Donner Lake from top of Tunnel Rock-3 miles distant.
127. 105 Donner Lake. Eastern Summits 25 miles distant.
128. 115 Boating Party on Donner Lake.

Hart
No. Miles Title Notes

129. 115 Donner Lake. Crested Peak and Mt. Lincoln in distance.
130. 115 View on Donner Lake, Altitude 5,964 feet.
131. 117 Donner Lake, with Pass in distance, Altitude above Lake 1,126 feet.
132. 116 Donner Lake, Peak and Pass, from Wagon Road.
133. 117 Stumps Cut by the Donner Party in 1846, Summit Valley. [123]
134. 17 Dry Creek Bridge, 17 miles from Sacramento.
135. 3 Locomotive on Trestle [at American River Bridge, 3/16/1865]
136. 23 Train and Curve-Jenny Lind Flat
137. 4 Bound for the Mountains-12 Mile Tangent. 4 Miles from Sacramento
138. 31 Freight Depot at Newcastle, Placer County.

123. Hart No. 133. This ends the first set of a rather orderly progression of views eastward from Newcastle to the east end of Donner Lake. The next 15 views were probably taken by Hart for Lawrence & Houseworth, published by them in 1865, and later resold to the CPRR or Hart.

Hart seemed to love the scenery around Donner Summit and Donner Lake. This may have been because of his long-standing interest in landscape painting, or because he believed his future stereo customers would share his feelings. He often arose very early and took numerous scenes of the lake when it was still glassy calm. He sometimes worked in the evening taking pictures of night fishing which he also sold to Lawrence & Houseworth. In night fishing, an iron basket (visible on the beach in No. 128) was filled with burning pine knots and hung out from the bow of the rowboat to attract fish to the light.

31 miles from Sacramento
139. 31 Locomotive on Turntable [124]

Hart

No.	Miles	Title	Notes

140. 22 Rocklin Granite Quarry, 22 miles from Sacramento
141. 24 Tangent below Pino [Photographer's shadow at right--Pino is now called "Loomis"]
142. 30 Antelope Ridge, near Newcastle, 30 miles from Sacramento.
143. 26 Griffith's Granite Station.
144. 3 American River Bridge-400 feet long.
145. 31.5 Building Trestle at Newcastle, Placer County.
146. 24.5 Train on Embankment above Pino, with hand-car near.
147. 28 Train at Griffith's Station, Placer County
148. 3 View of American River Bridge, near view-3 miles from Sacramento.[125]
149. 55 Colfax, looking West, Illinoistown in distance.
150. 55 Colfax looking West-Cape Horn and Giant's Gap.
151. 57 Cape Horn, from Ravine below.
152. 57 Cape Horn, from American River, Railroad 1400 feet above.
153. 71 Hog's Back Cut, 60 feet deep. 2 miles above Alta.
154. 72 American River, from Green Bluffs.

Hart

124. Hart No. 139. Taken at Newcastle after March 16, 1865 when the CONNESS took its maiden trip and before the Newcastle trestle was completed in April 1865.

125. Hart No.148. With a strong glass, a large locomotive with its tender full of people can just be seen at the other end of the bridge. It is standing alone without any cars. This may be the CONNESS shown in Hart No. 135 which would set the date for this scene aa March 16, 1865 (Fig. 5 on page 23 is an enlargement of No. 148). This ends the inserted set of L & H views between Sacramento and Newcastle with their disordered regard for distances from Sacramento. In addition, they were taken earlier than Hart Nos. 1 to 133.

No.	Miles	Title	Notes

155. 72 View of the Forks of the American River, 3 miles above Alta.
156. 75 Prospect Hill Cut, 150 feet deep, 74 feet wide.
157. 76 Railroad West from Fort Point.
158. 78 Across Blue Canyon, looking East.
159. 78 Blue Canyon Embankment-75 feet high.
160. 79 Blue Canyon-79 miles.
161. 79 Across Blue Canyon, looking West.
162. 80 Lost Camp Spur Cut, 80 miles from Sacramento.

Hart

No.	Miles	Title	Notes

163. 84 Frame for Snow Covering, interior view.
164. 84 Emigrant Gap, Snow Plow and Turn Table.
165. 84.4 Emigrant Gap, West from Tunnel.
166. 84.4 Emigrant Gap Tunnel
167. 84.5 Emigrant Gap, looking East, Yuba Mountains in the distance.[126]
168. 85 Bear Valley, 85 miles from Sacramento.
169. 88 Valley, North Fork of Yuba, above Emigrant Gap. Old Man Mountain.[127]
170. 88 Cement Ridge, Old Man Mountain in distance.

126. Hart No. 167. In this scene the train is heading west, evidently returning from some point up the line, like Cisco. There was a turntable at Cisco, 7-1/2 miles above this point, reached by the tracks on November 29, 1866. Hart's photo wagon is parked on the 3rd flat car. The photo wagon suggests an off-rail excursion; so this trip might be dated in the spring or summer of 1867.

127. Hart No.169. In this view, Hart has set his camera tripod on top of the baggage car just behind the tender in order to photograph the inside of the cab and the distant mountains. In the next view (No.170), he is on the roof, about the middle of the second (passenger) car, and in No. 171 he has moved about 200 yards behind the train to photograph all three cars including the flatcar at the rear with his photo wagon on it. The train is headed east.

171. 88 Miller's Bluffs-Old Man Mountain in dist.
172. 89 Echo Point, opposite Crystal Lake, looking West.
173. 89 Echo Point and Rattlesnake Mountains.

Hart
No. Miles Title Notes

177. 91 Crystal Lake and Railroad, from Black Butte.
178. 91 South Yuba Valley and Summits from Black Butte.
179. 98 Old Man Mountain, near Meadow Lake. Altitude 7,500.[128]
180. 98 Meadow Lake, 6,800 elevation. Knickerbocker Hill and Old Man Mountain.
181. 92 North Fork of South Yuba, near Meadow Lake.
182. 92 "Oneonta" at Cisco.
183. 92 Main Street Upper Cisco, 5911 feet elevation.
184. 92 Upper Cisco, Rattlesnake and Yuba Mountains.
185. 92 Depots at Cisco, Altitude 5,900 feet.
186. 92 View of the South Yuba, below Cisco
187. 105 Summits of Sierras. 8,000 to 10,000 feet altitude.
188. 106 Castle Peak, a Western Summit, 10,000 feet altitude.
189. 105 Summit of Castle Peak-10,000 feet altitude.
190. 105 Summit of Castle Peak-10,000 feet altitude, from the Northwest.
191. 104 Summit Valley, from Emigrant Mountain, looking West.
192. 104 Anderson's Valley and Devil's Peak, from Emigrant Mountain. Western Summit.

Hart
No. Miles Title Notes

128. Hart No. 179 shows a photographer and a large camera like the one in Appendix A, view 188(a) at the extreme left. When No. 179 was published by Watkins, the man and camera were masked out. Was this an accident, or is the man Alfred Hart, toward whom Watkins may have felt some guilt for not having given him credit for taking these photographs?

174. 90 Railroad, below Cisco and Crystal Lake.
175. 91 Foot of Black Butte [opposite Crystal Lake]
176. 91 Black Butte, 91 Miles from Sacramento.

193. 104 Summit Station, Western Summit. [One mile above Norden, California.]
194. 104 Lakes in Anderson Valley, from Lava Bluff.
195. 105 American Peak, in Spring, View near the Pass, Western Summit.
196. 105 Shaft house over Summit Tunnel, American Peak in distance.[129]
197. 105 Summit Tunnel, before completion: Western Summit-Altitude 7,042 feet.
198. 105 East portal Summit Tunnel. Length 1,660 feet.
199. 105 Wagon Road and East Portal of Summit Tunnel. Altitude 7,000 feet
200. 105 Bluff and Snow Bank in Donner Pass.
201. 105 Melting of a Snow Bank, Scene on the Summit in August
202. 105 East Portals of Tunnels Nos. 6 and 7, from Tunnel No. 8.

Hart
No. Miles Title Notes

203. 105 Donner Lake, Tunnels No. 7 and 8, from Summit

129. Hart No. 196. Work on the Summit Tunnel was proceeding slowly in 1866 when a group of officials from the Union Pacific came to "check on the competition." Even though Strobridge was working from both ends of the tunnel, the UP group reported to their superiors that they had plenty of time as it would take the Central Pacific at least three years to finish the tunnel. On August 27, 1866, shortly after they left, Strobridge began a 73-foot-deep shaft at the center of the tunnel so that four faces could be worked simultaneously. It took 85, 24-hour days to sink the shaft through solid granite using black powder and hand drilled holes. To lift out the waste rock, the locomotive SACRAMENTO (the first one in California) was brought on a giant logging wagon 25 miles from the railhead at Alta. Using Oxen, chains, profanity, and incredible effort the trip was made in six weeks. The locomotive was connected to a mine hoist in the 50 foot square shaft house, and with its help Strobridge finished the tunnel in 18 months. The top of the shaft, now covered, can be seen about 100 feet south of old highway 40. The *Sacramento Union* reported on May 3, 1869, (p. 8 column 6) that the old SACRAMENTO had been overhauled and was busy hauling a cobble train (for street paving).

Tunnel, Eastern Summit in distance.[130]

204. 105 Heading of east portal Tunnel No. 8.
205. 116 Donner Lake and Crested Peak--Railroad Grade on Pollard's Hill
206. 113 Coldstream Valley, from Tunnel No. 13.
207. 115 Coldstream, Eastern slope of Western Summit.
208. 115 Coldstream Valley
209. 107 View from Crested Peak-8,500 feet altitude. Donner Lake and Railroad Line.[131]
210. 92 Loaded Teams from Cisco [Sign says "Half Way House"]
211. 77 West Portal Tunnel No. 1, Grizzly Hill.
212. 93 North Fork of Yuba River, between Cisco and Meadow Lake.
213. 91 Snow Covering below Cisco.
214. 84 Emigrant Gap Ridge, 84 miles. Old Man Mountain, Red Mountain, Castle Peak, in distance.

Hart No.	Miles	Title	Notes

215. 84 Bear Valley and Yuba Canyon, from Emigrant Gap.
216. 73 View at Shady Run. 73 miles from Sacramento.
217. 92 All aboard for Virginia City, and the overland mail.[132]

130. Hart No. 203 probably depicts the visit of Senator Milton S. Latham's party of eight to the summit on April 13, 1867. In a letter, Leland Stanford mentions Latham had told him the party enjoyed the trip and had entered the tunnel. George T. Clark, *Leland Stanford,* (Stanford University, California: Stanford University Press, 1931) p. 225.

131. Hart No.209. The western portal of unfinished Tunnel 10 is visible 1,100 feet below. Hart's camera location for this photograph is clearly shown in No. 256, taken from the other (eastern) end of tunnel 10 at track level. He had to move his dark tent, tripod, camera and wet plates to this high location.

132. Hart No. 217. This view was carefully posed and taken of the stage coaches loading at the Cisco passenger station (enlarged in Fig. 43). Incidentally No.217(a), taken at the same time and closer to the locomotive is one of the finest views to be found in Hart's CPRR series. The negative was also published by Thomas Houseworth as his No.1256.

218. 93 Tunnel No. 3, above Cisco.
219. 92.5 View above Cisco, looking towards the Summit.
220. 118 Scene on the Truckee River, near Donner Lake.
221. 121 Truckee River below Truckee Station, looking west toward Donner Lake.
222. 121 Truckee River, below Truckee Station, looking towards Eastern Summit.
223. 121.5 Truckee River, approaching the Eastern Summits.
224. 133 First crossing of the Truckee River. 133 miles rom Sacramento. [Shadow, Hart's head]
225. 133 Bridge over First Crossing Truckee River. 204 feet long.[Shadow of camera and tripod]
226. 133 Interior of Bridge over First Crossing of the Truckee River.
227. 133.3 Profile Rock, near the First Crossing of the Truckee River.
228. 134 Truckee river entering the Eastern Summits. Tunnel No.14. 134 miles.
229. 58 American River Bridge. Railroad around Cape Horn, 1400 feet above.

Hart No.	Miles	Title	Notes

230. 58 View on the American, below Cape Horn [from bridge to Iowa Hill]
231. 34 Bloomer Cut, near Auburn. 800 feet long and 65 feet high. [white photo wagon, RR car]
232. 22 Capital Granite Quarry at Rocklin. 22 miles from Sacramento.
233. 22 Cutting Granite at Rocklin, 22 miles from Sacramento.
234. 0 Railroad Wharves, at Sacramento City.
235. 0 J Street, Sacramento City. View from the Levee.
236. 133.8 Cathedral Rock. Camp 20
237. 105 Crested Peak, from Grant's Butte.
238. 117 Cloud View, Donner Lake

239. 92 Snow Plow, at Cisco
240. 22 Engine House and Train. Rocklin, 22 miles from Sacramento.
241. 22 Engine House and Turntable. Rocklin 22 miles from Sacramento.
242. 42 West of Clipper Gap, Placer County.
243. 43 Clipper Gap, 43 miles from Sacramento.
244. 49 Cut near New England Mills. 49 miles from Sacramento
245. 56 Railroad around Cape Horn. From the Canyon.
246. 107.6 Constructing Snow Cover. Scene near the Summit.
247. 90 Frame of Snow Covering, 90 miles from Sacramento.
248. 97.5 Lower Cascade. Near long side track.
249. 97.5 Lower Cascade Bridge. Above Cisco.
250. 98 Upper Cascade. 98 Miles from Sacramento.
251. 99 Upper Cascade Bridge. Above Cisco.

Hart
No. Miles Title Notes

252. 106.7 Snow Gallery around Crested Peak. Timbers 12x14 in.,20 in. apart. [133]
253. 106.7 Crested Peak from Railroad. Roof of Snow Gallery.[The closer man identified as Arthur Brown in Huntington Library collection]
254. 106.7 Inside view of Snow Gallery at Summit. Bolting the Frame to the Rocks.
255. 107.5 From Tunnel No. 10 looking West. Building Great Wall across the Ravine.
256. 107.6 Crested Peak and Tunnel No. 10. Eastern Slope of Western Summit.[134]

133. Hart No. 252. The huge amount of material that had to be kept clear of the tracks, while building the snowsheds over this busy section of the railroad, can be seen on both sides (Fig. 47. is a modern view of this location).

134. Hart No. 256. With all his cumbersome equipment, Hart climbed up to the right end of the rocky "crest" shown in the distance to take No. 209 facing back to the west end of tunnel No.10--1,100 feet below his location on the mountain now known as "Donner Peak."

257. 108 Tunnel No. 12. Strong's Canyon.
258. 110 Castle Peak, from Railroad. Above Donner Lake.
259. 113.5 Coldstream Valley, Stanford's Mill
260. 116 Mist rising from Donner Lake. Early Morning View.
261. 116 Railroad around Crested Peak. View from foot of Donner Lake.
262. 119 Depot at Truckee. 119 miles from Sacramento.
263. 119 Scene at Truckee. Nevada County.
264. 120 Truckee River, at Truckee Station. 15 Miles from Lake Tahoe.

Hart
No. Miles Title Notes

265. 127 Boca. Crossing of Little Truckee. [135]
266. 137.9 View of Truckee River. Near Camp 24.
267. 138 View near the [old] State Line, Truckee River.[136]
268. 137.5 Boundary Peak and Tunnel No.15. 137 miles from Sacramento.
269. 137.4 Tunnel No.15. Looking East, toward Nevada.
270. 137.6 Tunnel No.15. Near Camp 24
271. 138 Bridge near State Line. 138 miles from Sacramento.
272. 138 Second Crossing of Truckee River. Near Camp 24.
273. 133 Bridge at Eagle Gap. Truckee River.
274. 133 Bridge over Truckee River, Eagle Gap.
275. 133 Eagle Gap, Truckee River.

135. Hart No. 265 This view is looking east toward Reno, Nevada. Just to the right of the flat cars loaded with railroad ties Crocker has had some heavy cribbing installed. The Central Pacific Ice Plant was erected above these logs, and the Little Truckee (crossing in the foreground under the bridge) was dammed about 1/4 mile to the left. Ice was harvested from the resulting lake, stored in the ice plant, and shipped out as needed. Earlier ice had come from the Summit Lakes, but the heavy snows had made ice harvesting very difficult. Before the Central Pacific reached Norden Station most commercial ice in California came from Alaska.

136. Hart No. 267. James D. Hart, *A Companion to California History* pp. 74 and 428 (citation courtesy of Kathy Correia of CSL) mentions this question, as does Owen C. Coy *California County Boundaries* (citation courtesy of James Henley director of Sacramento History and Science Division).

In 1873 after the Railroad was finished, the line between California and Nevada was moved so that the new State Line was 140 miles from Sacramento by rail. The new survey didn't give California 2 extra miles to the east, but the railroad at this point was going almost due north (actually NNE) to Reno; so a small change in the boundary line added 2 miles to the total distance from Sacramento.

276. 143 View near Verdi, Truckee River.
277. 140 Looking toward Verdi. Truckee River, 140 milesfrom Sacramento.

Hart

No.	Miles	Title	Notes

278. 142 Bridge below Verdi.
279. 147 Fourth Crossing of Truckee River. 147 miles from Sacramento.
280. 150 Granite Quarry. Near Reno.
281. 152 Reno and Washoe Range in distance. From Base of Sierra Nevada Mountains
282. 154 Piute Squaws and Children at Reno. [137]
283. 154 Piute Indians. [Seems same background as No. 282.]
284. 154 Freight Depots at Reno, 154 miles from Sacramento.
285. 154 Scene at Depot, at Reno
286. 154 Virginia Street, from the Bridge, Reno
287. 160 Entering Lower Canyon of Truckee River. [138]

Hart

No.	Miles	Title	Notes

288. 162 Looking across Truckee Meadows, toward Sierra Nevada Mountains, near Camp 37.

137. Hart No. 282. In Hart's day, the word "squaw" was thought to be a North American Indian word meaning "woman" and especially "wife." Hart seemed to be interested in their customs, and he published an untitled stereo view of another Piute mother and child, taken from the side while she demonstrated carrying the baby in its cradleboard. Now Piute people call the cradle board (in English) a baby carrier or baby cradle. In the Piute language it is pronounced "Hoop." The pattern on top of the bonnet denotes the sex of the baby, a zig-zag pattern for girls and a series of parallel lines or slashes for boys. This information courtesy of Dr. Kay Fowler of the University of Nevada Anthropology Department.

138. Hart No. 287. The exact purpose of the heavy rope on the rear of the tender is not clear. Occasionally one appears in a picture of a construction train locomotive (Fig. 32), particularly those hauling cars of rails--as in this case. A coupling link (a heavy iron elongated circle) is spliced at the end of the rope for easy attachment to a car coupling. The rope could have been used for moving a car on a parallel siding while the locomotive remained on the main line. For just pulling, say of a car that had lost its coupling link, the rope would also work, but backing would have been difficult. On dry clean track, these 1868 locomotives could exert a "tractive effort" or horizontal pull of over five tons. A modern large diesel/electric locomotive may weigh over 170 tons and can exert over 28 tons of tractive effort.

289. 162 Truckee Meadows. Sierra Nevada Mountains 20 miles distant.
290. 162 Truckee Meadows, from Camp 37, 162 miles from Sacramento.
291. 162 Scene near Camp 37
292. 164.0 Below Camp 37. Lower Canyon of Truckee.
293. 164.0 Crossing of Wagon Road. Lower Canyon of Truckee.
294. 165.0 Cottonwood Valley. Lower Canyon of Truckee.
295. 165.0 Scene on Bank of Truckee River. Lower Canyon of Truckee.[Seems taken from photo wagon in No. 294]
296. 174.0 Basaltic Rocks. Lower Canyon of Truckee.
297. 174.0 View from Basaltic Rocks, looking East.
298. 176 Limestone Point. Lower Canyon of Truckee.
299. 176 Truckee River and R.R. at Lime Point Sierra Nevada Mountains 35 miles distant.
300. 177.0 Pleasant Valley. Lower Canyon of Truckee.
301. 177.0 Pleasant Valley, looking West, Lower Canyon of Truckee River.
302. 177.0 Pleasant Valley, looking East. Lower Canyon of Truckee River.
303. 178 Red Bluffs, looking from the West Lower Canyon of Truckee River. Lower Canyon of
304. 179 Looking West from Red Bluffs, Truckee River.
305. 179 Red Bluffs, Lower Canyon of Truckee, 179 miles from Sacramento.
306. 187 Truckee River, near Wadsworth, Lower Canyon of Truckee.

Hart

No.	Miles	Title	Notes

307. 188 The Goliah, at Wadsworth. Big Bend of Truckee River.
308. 188 Wadsworth-Big Bend of Truckee R. Washoe Range in distance.
309. 188 Turntable at Wadsworth, 188 miles from Sacramento.
310. 232 Construction Train on Desert. near Humboldt Lake.

311. 233.0 Construction Train on Alkali Dessert. [Sic]
312. 233.0 Alkali Flat, Construction Train in distance.
313. 234 Chinese Camp, Brown's Station
314. 234 Brown's Station, 234 miles from Sacramento.
315. 235.0 Water Train, opposite Humboldt Lake.
316. 240.0 End of Track. On Humboldt Plains.
317. 235.0 End of Track, near Humboldt Lake.
318. 254 Lower Crossing of Humboldt River. 254 miles from Sacramento.
319. 325 Winnemucca Depot. 334 miles from Sacramento.[139]
320. 325 Winnemucca Town and Peak, 334 miles [see fn. 139] from Sacramento.
321. 353 Advance of Civilization. End of Track, near Iron Point.
322. 354.0 Advance of Civilization. On Humboldt Desert.
323. 355.0 Shoshone Indians, looking at Locomotive on Desert.
324. 355.0 Shoshone Indians. Humboldt Plains.

Hart No.	Miles	Title	Notes

325. 355.0 Car of Sup't of Construction. End of Track.
326. 395 Argenta Station, at Skull Ranch, 395 miles from Sacramento.
327. 426.0 Chinese Camp, at End of Track
328. 428.0 Powder Bluff. West End of 10 mile Canyon.
329. 430 Second Crossing of Humboldt River. 430 miles from Sacramento.
330. 431.0 Commencement of a snow Storm. Scene East of Second Crossing of Humboldt
331. 432 Sentinel Rock. Ten Mile Canyon.
332. 432.5 Team Camp-Evening View, End of Track.

139. Hart No. 319. This seems to be an interesting case where Hart's mile figure is about 9 miles off. The builders covered the 71 miles from his last photograph in about a month, and in that part of Nevada one mile looks a lot like another. Hart may have been back in Sacramento, and this was his first view upon returning. The "325 miles" was taken from a very complete table on page 310 of George Kraus's *High Road to Promontory* (1969) which generally agrees with Hart within a mile.

333. 433.0 Curving Iron. Ten mile Canyon.
334. 434.0 Humboldt Gate. Ten Mile Canyon.
335. 434.0 Building Water Tank. Trout Creek Mountains in distance.
336. 435 Entering the Palisades, Ten Mile Canyon.
337. 435 The Palisades-10 Mile Canyon. 435 miles from Sacramento.
338. 435 First Construction Train passing the Palisades, Ten Mile Canyon.[140]
339. 435 Alcove in Palisades, Ten Mile Canyon.
340. 435 Indian viewing R.R. from top of Palisades. 435 miles from Sacramento.

Hart No.	Miles	Title	Notes

341. 435 View across River and Canyon, from top of Palisades.
342. 435.0 Shoshone Indians. Ten Mile Canyon.
343. 396 Train at Argenta, 396 miles from Sacramento.
344. 445 Machine Shops at Carlin. 445 miles from Sacramento.
345. 445 Carlin from the Water Tanks, Looking West.
346. 468 Depot at Elko, 468 miles from Sacramento.
347. 468 Elko from the West. 468 miles from Sacramento.
348. 488 Water Tank at Peko. 488 miles from Sacramento.
349. 505 Scene near Deeth. Mount Halleck in distance.
350. 682 Railroad Camp near Victory.10-1/4 miles laid in one day.[141]

140. Hart No. 338. The track is so new that the ties are just sitting on the road bed without gravel ballast. The locomotive is an old war horse with the decorative front of the smoke-box gone, the bars of the pilot or cowcatcher bent, and no screen on the top of the stack. The man standing at right is probably Strobridge. A great photograph of some tough men and machinery. Just as soon as the CPRR reached Promontory, 19 work-worn locomotives had to be sent to Sacramento for complete overhaul. (Enlarged in figure 17, page 37)

141. Hart No. 350. There is no certain evidence that Hart was in Utah on April 28th, 1869, when Strobridge and his tracklayers completed 10 miles of track in one day. Considering the way Hart pictured tunnel and snow shed building, if present, he probably would have produced a number of views of the great tracklaying contest. Three hundred miles to the west he

Hart No.	Miles	Title	Notes
351.	669	Monument Point from the Lake, 669 miles from Sacramento [The Point itself was at 674 miles]	
352.	669	Salt Lake from Monument Point. 669 miles from Sacramento.	
353.	669	Poetry and Prose. Scene at Monument Point, North end of Salt Lake. [142]	
354.	690	The First Greeting of the Iron Horse. Promontory Point, May 9th, 1869.[143]	
355.	690	The Last Rail. The Invocation, Fixing the Wire, May 10,1869	
356.	690	The Last Rail is Laid. Scene at Promontory Point, May 10th, 1869.	
357.	690	The Rival Monarchs. Scene at Promontory Point, May 10th, 1869. [see also Fig. 26]	
358.	690	The Monarch from the West. Scene at Promontory Point, May 10th, 1869. [see also Fig. 24]	
359.	690	The Monarch from the East. Scene at Promontory Point, May 10th, 1869.	
360.	690	The Last Act-690 Miles from Sacramento. Scene at Promontory Point, May 10th, 1869.	
361.	740	Looking West from Taylor's Mills. Near Ogden.[144]	
362.	740	Taylor's Mills, Wasatch Range. Near Ogden.[145]	
363.	742	Ogden and Wahsatch [sic] Range, 742 miles from Sacramento.	
364.	742	Railroad at Ogden, Wahsatch [sic] Range in distance.	

[A copy in the Huntington Library collection identifies the man in the tall hat at right as the English capitalist, William Blackmore.]

photographed more leisurely end-of-track scenes in Nos. 317 and 321. He was on Stanford's train to Promontory which passed "Camp Victory" or Rozel (8 miles west of Promontory) in the early afternoon of cold and cloudy Friday, May 7th. To keep his men separated from the hard-drinking UP crews, Strobridge had moved his workers back to Rozel after the April 30th completion of the Central Pacific track. It would have been logical to have Strobridge and his remaining workers pose at the camp where they ate lunch on the great day, one week earlier. The clerestory top passenger car just behind the men at the left (in No. 350) is exactly like Stanford's car in Nos. 351 and 360.

A

s one would expect on an overcast day, there are no shadows of vertical objects in this scene. In this writer's opinion, No. 350 was taken one week after April 28, 1869, when Strobridge (standing, facing the camera) and his construction crew had laid over 10 miles of track in a single day. Using heavy track tongs, eight mighty Irish tracklayers lifted and set in place all the rails totaling 1,973,290 pounds, or 246,661 pounds per man. Each single rail weighed 560 pounds and was lifted by four men, making 1762 lifts of 140 pounds for each individual. For this day they received double pay. At the end of that day, they were only about four miles from Promontory, and two days later their work was finished except for the last rail. In the background is thus the last construction camp used in the race to Promontory.

142. Hart Nos. 351, 352, & 353. These three views document a visit by Stanford's party on Sunday May 9,1869. The evening before they had returned to Stanford's train and moved back the 21 miles to Monument Point to stay by the lake. Although this scene is often cited as the only view of Stanford's entire train, it can also be seen at an angle in No. 360 (See footnote 144 for a list of activities on Saturday, the day before).

143. Hart No. 354. The meeting shown in No. 354 occurred at 5:15 p.m. May 9,1869 and was described in the San Francisco *Alta*. Hart must have returned from Monument Point aboard the Stanford train before 5 p.m. on the 9th. He was skilled at staging railroad photo-opportunities and may have actually set this one up. The cloudy weather looks right for the 9th, as the 10th was sunny.

144. Hart Nos. 361 through 364. These four views document a visit by Stanford's party on Saturday May 8, 1869. They had arrived at Promontory on Friday afternoon, May 7th, expecting the ceremony to occur the next day. Because of the delays in completing the Union Pacific, the final junction was set back to noon on Monday, May 10th. Late Friday afternoon some of the Stanford group hired buggies and drove east to the nearest UP construction camp where a special UP train met them for a trip to Ogden. They spent the night there and the next morning General Casement took them on a tour in a caboose pulled by UP locomotive No.117. That evening they returned to Stanford's train and moved back the 21 miles to Monument Point by the Great Salt Lake.

145. Hart No.362. The *San Francisco Evening Bulletin* reported that on May 8, 1869, General Hoxie, Assistant Superintendent of the Union Pacific Railroad entertained Stanford's party at a splendid luncheon at Taylor's Mills, a hamlet on the bank of the Weber River.

APPENDIX C

GEOGRAPHICAL LIST
(ARRANGED BY MILES FROM SACRAMENTO)

OF

ALFRED HART'S CPRR STEREO VIEWS

GEOGRAPHICAL LIST OF CPRR STEREOGRAPHS
BY ALFRED HART

Some titles are shortened in this list. For full title see Appendix B. "Miles" indicates miles from Front street, Sacramento.
(".0" after mile figure means estimated distance)

Hart No.	Miles	Title	Notes
234.	0	Railroad Wharves, at Sacramento City.	
235.	0	J Street, Sacramento City. View from the Levee.	
148.	3	View of American River Bridge, near view-3 miles from Sacramento.	
135.	3	Locomotive on Trestle [3/16/1865]	
144.	3	American River Bridge-400 feet long.	
137.	4	Bound for the Mountains-12 Mile Tangent. 4 Miles from Sacramento.	
134.	17	Dry Creek Bridge, 17 miles fr. Sacramento.	
233.	22	Cutting Granite at Rocklin, 22 miles from Sacramento.	
232.	22	Capital Granite Quarry at Rocklin. 22 miles from Sacramento.	
241.	22	Engine House and Turntable. Rocklin 22 miles from Sacramento.	
140.	22	Rocklin Granite Quarry, 22 miles from Sacramento.	
240.	22	Engine House and Train. Rocklin, 22 miles.	
136.	23	Train and Curve-Jenny Lind Flat.	
141.	24	Tangent below Pino [Photographer's shadow at right].	
146.	24.5	Train on Embankment above Pino, with hand-car near.	

Hart No.	Miles	Title	Notes
147.	26	Train at Griffith's Station, Placer County	
143.	26	Griffith's Granite Station.	
142.	30	Antelope Ridge, near Newcastle, 30 miles from Sacramento.	
2.	31	Trestle at Newcastle.	
139.	31	Locomotive on Turntable.	
138.	31	Freight Depot at Newcastle, Placer County. 31 miles.	
1.	31	Locomotive "Gov. Stanford" No.1.	
3.	31	Depot and Trestle, Newcastle. [Lady at L].	
145.	31.5	Building Trestle at Newcastle, Placer County.	
4.	31.5	Road above Newcastle, Placer County.	
7.	32	Embankment in Dutch Ravine, above Newcastle.	
6.	32	View in Dutch Ravine, 32 miles from Sacramento.	
5.	32	Railroad in Dutch Ravine, looking west.	
13.	33	View in Bloomer Cut, near Auburn.	
14.	33	In Bloomer Cut.	
12.	33	Bloomer Cut, 63 feet high, looking west.	
231.	33	Bloomer Cut, near Auburn. 800 feet long, 63 feet high.	
10.	33	Bloomer Cut, bird'seye view, 63 feet deep, 800 long.	

Hart No.	Miles	Title	Notes
8.	33	Approaching Bloomer Cut, from the West.	

11. 33 Bloomer Cut and Embankment, looking E.
9. 33 Bloomer Cut, 800 feet long, looking East.
15. 34 Embankment 60 feet high in Buckeye Rav.
16. 34.5 Cut West of Auburn.
18. 35 High Embankment, near Auburn.
19. 35 Trestle opposite Auburn.
17. 35 Rock Ravine, near Auburn.
20. 35.5 Cut near Auburn Station, Placer County.
21. 35.5 Trains at Station, Auburn.
22. 36 Road East of Station, at Auburn.
24. 37.0 Lime Point above Auburn.
23. 38 Road in Auburn Ravine, Placer County.
25. 38 High Embankment, Auburn Ravine.
26. 39 Auburn Ravine.
28. 40 Road and Trestle, near Lovell's Ranch.
27. 40 Trestle near Lovell's Ranch, 40 miles.
242. 42 West of Clipper Gap, Placer County.
31. 42 Trestle bridge, Clipper Ravine, near view.
30. 42 Trestle Bridge, 600 feet long, Clipper Ravine.
29. 42 Trestle in Clipper Ravine, nr. Clipper Gap.
32. 43 View above Clipper Gap, Placer County.
243. 43 Clipper Gap, 43 miles from Sacramento.
244. 49 Cut near New England Mills. 49 miles.
37. 55 Teamster's Camp at Colfax, Placer County.
36. 55 Colfax from the South, Altitude 2,448 feet.
149. 55 Colfax, looking West, Illinoistown in dist.
150. 55 Colfax looking West-Cape Horn and Giant's Gap.
35. 55 Depot at Colfax. 500 feet long.

Hart

No.	Miles	Title	Notes
33.	55	Locomotive Nevada at Colfax. 55 miles.	
34.	55	Locomotive Atlantic at Colfax, Placer County.	
41.	56	Long Ravine Bridge-near view [from west].	
42.	56	Long Ravine Bridge from below, 120 feet high.	
43.	56	Cape Horn and Railroad from the West.	
40.	56	Long Ravine Bridge from the west. 56 miles from Sacramento.	
38.	56	Canyon of Amer. River from west. Cape Horn and RR on left.	
39.	56	Long Ravine Bridge, from top of Cape Horn.	
245.	56	Railroad around Cape Horn. From the Canyon.	
56.	57	Rounding Cape Horn. Road to Iowa Hill from the river, in distance.	
151.	57	Cape Horn, from Ravine below.	
44.	57	Amer. R. and canyon from Cape Horn--river below R.R 1400 feet, 57 miles.	
152.	57	Cape Horn, from American River, Railroad 1400 feet above.	
57.	58	Excursion Train at Cape Horn. 3 miles above Colfax.	
230.	58	View on the American, below Cape Horn [from bridge].	
229.	58	American River Bridge. Railroad around Cape Horn.	
45.	59	Sawmill and Cut east of Cape Horn. 59 miles from Sacramento.	
58.	61	Secret Ravine, Iowa Hill in the distance. 61 miles from Sacramento.	
46.	61	Deep Cut at Trail Ridge. Length 1000 feet.	

Hart

No.	Miles	Title	Notes
47.	62	Secrettown, 62 miles from Sacramento.	
48.	62	Secrettown Trestle, from the West. Length 1,100 feet.	
49.	62	Secrettown Trestle, from the East. Height 90 feet.	
74.	62	Secrettown Bridge, 1,100 feet long.	
50.	63	Tunnel Hill Cut. Depth 111 feet. 63 miles	

from Sacramento.

52. 63.5 Bear River Valley-Little York mines in the distance.

51. 63.5 Bear River Valley-You Bet and mines in the distance.

60. 64 Train in Dixie Cut.

53. 64 Cut through "Dixie Spur."

59. 64.5 Hornet Hill Cut, west of Gold Run. 50 feet deep.

61. 65 Hydraulic Mining at Gold Run, Placer County.

55. 65 Railroad and Flume at Gold Run.

54. 65 Gold Run and Railroad Cut. Alt.3245 feet.

62. 66 Embankment below Dutch Flat, Placer Co.

65. 67.5 View near Dutch Flat.

66. 68 Sandstone Cut near Alta.

64. 67 Dutch Flat Station. 67 miles.

63. 67 Dutch Flat. Placer County. 67 miles.

68. 69 Alta from the North. 69 Miles.

69. 69 The Huntington at Alta.[Locomotive].

75. 69 Superintendent Strobridge and Family, at Alta.

Hart

No.	Miles	Title	Notes

67. 69 Alta from the South. Altitude 3,350 feet.

68. 69.1 Alta from the North, 69 miles.

73. 69.3 Cut above Alta.

70. 69.5 Blasting at Chalk Bluffs above Alta. Cut 60 feet deep.

71. 70 Building Bank across Canon Creek. 87 feet high.

72. 70.5 Culvert at Canyon Creek. 185 feet long-12 feet span.

78. 71 Green Bluffs, 1,500 feet above American River. 71 miles from Sacramento.

153. 71 Hog's Back Cut, 60 feet deep. 2 miles above Alta.

154. 72 American River, from Green Bluffs.

155. 72 View of the Forks of the American River, 3 miles above Alta

76. 72 Giant's Gap, American River, 2,500 feet perpendicular.

77. 72 Green Valley and Giant's Gap. American River. 1500 below.

216. 73 View at Shady Run. 73 miles.

81. 74 Little Blue Canyon. 74 miles from Sacramento.

80. 75 Prospect Hill from Camp 21. 75 miles.

84. 75 View at China Ranch. 75 miles.

83. 75 Prospect Hill Cut. from the north.

156. 75 Prospect Hill Cut, 150 feet deep, 74 feet wide.

82. 75 Prospect Hill Cut. Upper slope 170 feet.

Hart

No.	Miles	Title	Notes

79. 75 View west of Prospect Hill. 75 miles from Sacramento.

85. 76 Fort Point Cut. 70 feet, 600 feet long.

157. 76 Railroad West from Fort Point.

86. 76 View North of Fort Point. 76 miles from Sacramento.

88. 77 Horse Ravine Wall and Grizzly Hill Tunnel. 77 miles from Sacramento.

87. 77 Horse Ravine. 77 miles from Sacramento.

211. 77 West Portal Tunnel No. 1, Grizzly Hill.

89. 77 Grizzly Hill Tunnel from the North. 500 feet long.

159. 78 Blue Canyon Embankment-75 feet high.

158. 78 Across Blue Canyon, looking East.

161. 79 Across Blue Canyon, looking West.

160. 79 Blue Canyon-79 miles.

90. 80 Bank and Cut at Sailor's Spur. 80 miles

from Sacramento.
91. 80 Owl Gap Cut. 900 feet long, 45 feet deep.
162. 80 Lost Camp Spur Cut, 80 miles from Sacramento.
92. 82 Heath's Ravine Bank. 82 feet high.
214. 84 Emigrant Gap Ridge, 84 miles. Old Man Mountain, Red Mt.& Castle Peak in dist.
164. 84 Emigrant Gap, Snow Plow and Turn Table.
163. 84 Frame for Snow Covering, interior view.
215. 84 Bear Valley and Yuba Canyon, from Emigrant Gap.
166. 84.4 Emigrant Gap Tunnel

Hart

No.	Miles	Title	Notes
165.	84.4	Emigrant Gap, West from Tunnel.	
167.	84.5	Emigrant Gap, looking East, Yuba Mountains in distance.	
168.	85	Bear Valley, 85 miles from Sacramento.	
169.	88	Valley, North Fork of Yuba, above Emigrant Gap.	
170.	88	Cement Ridge, Old Man Mountain in dist.	
171.	88	Miller's Bluffs-Old Man Mountain in dist.	
173.	89	Echo Point and Rattlesnake Mountains.	
172.	89	Echo Point, opposite Crystal Lake, looking West.	
95.	90	Crystal Lake House. 90 mi. fr. Sacramento.	
247.	90	Frame of Snow Covering, 90 miles from Sacramento.	
174.	90	Railroad, below Cisco and Crystal Lake. Yuba River.	
175.	91	Foot of Black Butte. [opposite Crystal Lake]	
96.	91	Cascades on the Yuba River, near Crystal Lake.	
94.	91	Crystal Lake. Altitude 5907 feet.	
93.	91	Black Butte and Crystal Lake. 91 miles.	
213.	91	Snow Covering below Cisco.	
97.	91	Rattlesnake Mountain and Yuba Cascades.	
178.	91	South Yuba Valley and Summits from Black Butte.	
177.	91	Crystal Lake and Railroad, from Black Butte.	
176.	91	Black Butte, 91 Miles from Sacramento.	
181.	92	North Fork of South Yuba, near Meadow Lake.	

Hart

No.	Miles	Title	Notes
182.	92	"Oneonta" at Cisco.	
184.	92	Upper Cisco, Rattlesnake and Yuba Mts.	
210.	92	Loaded Teams from Cisco [Sign says "Half Way House"].	
185.	92	Depots at Cisco, Altitude 5,900 feet.	
217.	92	All aboard for Virginia City, and the overland mail.	
239.	92	Snow Plow, at Cisco.	
186.	92	View of the South Yuba, below Cisco.	
183.	92	Main Street Upper Cisco, 5911 feet elevation.	
102.	92	Hieroglyphic Rocks.	
98.	92	Black Butte from the North.	
101.	92	Pictured Rocks on Yuba R. near Crystal L.	
103.	92	Pictured Rocks.	
99.	92	Lower Cisco, Placer County, 92 miles.	
100.	92	Yuba Cascade and Hieroglyphic Rocks, on the Yuba River.	
219.	92.5	View above Cisco, looking to the Summit.	
218.	93	Tunnel No. 3, above Cisco.	
212.	93	North Fork of Yuba River, between Cisco and Meadow Lake.	
104.	93	Yuba River, above Cisco, Placer County.	
105.	96	New Hampshire Rocks on Yuba River, Summer View. 96 mi. from Sacramento.	
107.	96	New Hampshire Rocks looking down the river.	
106.	96	New Hampshire Rocks on Yuba River,	

Summer View. 96 miles.
108. 96 Scene on Yuba River, above Cisco.

Hart
No. Miles Title Notes

180. 98 Meadow Lake, 6,800 elevation: Knickerbocker Hill & Old Man Mtn.
179. 98 Old Man Mountain, near Meadow Lake. Altitude 7,500.
249. 98.5 Lower Cascade Bridge. Above Cisco.
248. 98.5 Lower Cascade. Near long side track.
250. 99 Upper Cascade. 98 Miles from Sacramento.
251. 99 Upper Cascade Bridge. Above Cisco.
109. 100 Summit Valley, Altitude 6,960 feet. Emigrant Mountain.
110. 100 Castle Peak from Lava Bluff. 11,000 feet above sea.
111. 102 Castle Peak and Yuba River, from Summit Valley. 102 miles from Sacramento.
193. 104 Summit Station, Western Summit [Now Donner Ski Ranch parking lot].
191. 104 Summit Valley, from Emigrant Mountain, looking West.
192. 104 Anderson's Valley and Devil's Peak, from Emigrant Mountain.
194. 104 Lakes in Anderson Valley, from Lava Bluff.
116. 105 Camp near Summit Tunnel-Mount King in the distance.
115. 105 Lake Angela, Mount King in the distance. Western Summit.
118. 105 Summit Tunnel-Eastern Portal. Length 1660 feet.
125. 105 Donner Lake from Summit, Lakeview Bluff on the right.

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No. Miles Title Notes

117. 105 Bluffs in Donner Pass, Western Summit, 500 feet high.
119. 105 Laborers and Rocks near opening of Summit Tunnel.
121. 105 Grant's Peak and Palisade Rocks-From Summit.
112. 105 Scene near Donner Pass, Table Peak in the distance.
126. 105 Donner Lake from top of Tunnel Rock.
113. 105 Castle Peak from Grant's Peak.
114. 105 Scene at Lake Angela. Altitude 7,300 feet.
127. 105 Donner Lake. Eastern Summits 25 mi. dist.
196. 105 Shaft house over Summit Tunnel, American Peak in dist.
197. 105 Summit Tunnel [interior], before completion.
199. 105 Wagon Road and East Portal of Summit Tunnel. Alt. 7000 feet.
195. 105 American Peak, in Spring, View near the Pass, Western Summit.
190. 105 Summit of Castle Peak-10,000 feet altitude, from the northwest.
120. 105 Scene near Summit Tunnel. Eastern Slope of Western Summit.
187. 105 Summits of Sierras. 8,000 to 10,000 feet alt.
189. 105 Summit of Castle Peak-10,000 feet altitude.
200. 105 Bluff and Snow Bank in Donner Pass.
198. 105 East portal Summit Tunnel. Length 1,660'.
203. 105 Donner Lake, Tunnels No. 7 and 8, from Summit Tunnel.

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No. Miles Title Notes

204. 105 Heading of east portal Tunnel No. 8.
237. 105 Crested Peak, from Grant's Butte.
201. 105 Melting of a Snow Bank, Scene on the Summit in August.
202. 105 East Portals of Tunnels Nos. 6 and 7, from

Tunnel No. 8.
122. 105.5 Palisade Rocks with Road and Teams descending Western Summit.
123. 105.5 Lakeview Bluff. 350 feet high. From the wagon road.
124. 106 Road and Rocks at foot of Crested Peak, Eastern Slope.
188. 106 Castle Peak, a Western Summit, 10,000' alt.
252. 106.7 Snow Gallery around Crested Peak. Timbers 12 x 14 in., 20 inches apart.
254. 106.7 Inside view of Snow Gallery at Summit. Bolting the frame to the rocks.
253. 106.7 Crested Peak from Railroad. Roof of Snow Gallery.
209. 107 View from Crested Peak-8,500 feet altitude. Donner Lake and RR line.
255. 107.5 From Tunnel No. 10 looking West. Building Wall across the ravine.
246. 107.6 Constructing Snow Cover. Scene near the Summit.
256. 107.6 Crested Peak and Tunnel No. 10.
257. 109 Tunnel No. 12. Strong's Canyon.
258. 110 Castle Peak, from Railroad. Above Donner Lake.

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No.	Miles	Title	Notes
206.	113	Coldstream Valley, from Tunnel No. 13.	
259.	113.5	Coldstream Valley, Stanford's Mill	
130.	115	View on Donner Lake, Altitude 5,964 feet.	
129.	115	Donner Lake. Crested Peak and Mount Lincoln in distance.	
128.	115	Boating Party on Donner Lake.	
207.	115	Coldstream, Eastern slope of W. Summit.	
208.	115	Coldstream Valley.	
260.	116	Mist rising from Donner Lake. Early Morning View.	
261.	116	Railroad around Crested Peak. View from foot of Lake.	
132.	116	Donner Lake, Peak and Pass, from Wagon Road.	
205.	116	Donner Lake and Crested Peak--Railroad Grade on Pollard's Hill.	
131.	117	Donner Lake, with Pass in distance, Altitude above Lake 1126 feet.	
133.	117	Stumps Cut by the Donner Party in 1846, Summit Valley.	
238.	117	Cloud View, Donner Lake.	
220.	118	Scene on the Truckee River, nr. Donner Lake.	
262.	119	Depot at Truckee. 119 miles from Sacramento.	
263.	119	Scene at Truckee. Nevada County.	
264.	120	Truckee River, at Truckee Station. 15 Miles from Lake Tahoe.	
222.	121	Truckee River, below Truckee Station, looking toward Eastern Summit.	

Hart

No.	Miles	Title	Notes
221.	121	Truckee River below Truckee Station, looking west	
223.	121.5	Truckee River, approaching the Eastern Summits.	
265.	127	Boca. Crossing of Little Truckee.	
274.	133	Bridge over Truckee River, Eagle Gap.	
275.	133	Eagle Gap, Truckee River.	
273.	133	Bridge at Eagle Gap. Truckee River.	
226.	133	Interior of Bridge over First Crossing of the Truckee River.	
224.	133	First crossing of the Truckee River. 133 miles from Sacramento.	
225.	133	Bridge over First Crossing Truckee River. 204 feet long.	
227.	133.3	Profile Rock, near the First Crossing	

236. 133.8 Cathedral Rock. Camp 20.
228. 134 Truckee river entering the Eastern Summits. Tunnel 14.
269. 137.4 Tunnel No.15. Looking East, to Nevada.
268. 137.5 Boundary Peak and Tunnel No.15. 137 miles from Sacramento.
270. 137.6 Tunnel No.15. Near Camp 24.
266. 137.9 View of Truckee River. Near Camp 24.
271. 138 Bridge near State Line. 138 miles.
267. 138 View near [old] State Line, Truckee River.
272. 138 Second Crossing of Truckee River. Near Camp 24.
277. 143 Looking toward Verdi. Truckee R.,140 mi.
278. 142 Bridge below Verdi.

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No.	Miles	Title	Notes

276. 143 View near Verdi, Truckee River.
279. 147 Fourth Crossing of Truckee River. 147 miles.
280. 150 Granite Quarry. Near Reno.
281. 152 Reno and Washoe Range in distance.
286. 154 Virginia Street, from the Bridge, Reno
285. 154 Scene at Depot, at Reno.
282. 154 Piute Squaws and Children at Reno.
283. 154 Piute Indians.
284. 154 Freight Depots at Reno, 154 miles.
287. 160 Entering Lower Canyon of Truckee River.
290. 162 Truckee Meadows, from Camp 37, 162 miles.
291 162 Scene near Camp 37.
289. 162 Truckee Meadows. Sierra Nevada Mountains.
288. 162 Looking across Truckee Meadows.
293. 164.0 Crossing of Wagon Road. Lower Canyon of Truckee River.
292. 164.0 Below Camp 37. Lower Can.. of Truckee.
295. 165.0 Scene on Bank of Truckee River.
294. 165.0 Cottonwood Valley. Lower Canyon of Truckee River.
296. 174.0 Basaltic Rocks. Lower Canyon of Truckee.
297. 174.0 View from Basaltic Rocks, looking East.
299. 176 Truckee River and R.R. at Lime Point.
298. 176 Limestone Point. Lower Canyon of Truckee River.
302. 177.0 Pleasant Valley, looking East. Lower Canyon.
300. 177.0 Pleasant Valley. Lower Canyon.
301. 177.0 Pleasant Valley, looking West, Lower Canyon of Truckee River.

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No.	Miles	Title	Notes

303. 178 Red Bluffs, looking from the West.
305. 179 Red Bluffs, Lower Canyon of Truckee, 179 miles from Sacramento.
304. 179 Looking West from Red Bluffs.
306. 187 Truckee River, near Wadsworth, Lower Canyon of Truckee River
309. 188 Turntable at Wadsworth, 188 miles from Sacramento.
308. 188 Wadsworth-Big Bend of Truckee R. Washoe Range in distance.
307. 188 The Goliah, at Wadsworth. Big Bend of Truckee River.
310. 232 Construction Train on Desert. Near Humboldt Lake.
312. 233.0 Alkali Flat, Construction Train in distance.
311. 233.0 Construction Train on Alkali Dessert.[sic.]
314. 234 Brown's Station, 234 miles from Sac'to.
313. 234 Chinese Camp, Brown's Station.
317. 235.0 End of Track, nr. Humboldt Lake.
315. 235.0 Water Train, opposite Humboldt Lake.
316. 240.0 End of Track. On Humboldt Plains.
318. 254 Lower Crossing of Humboldt River. 254 miles from Sacramento.
320. 325 Winnemucca Town and Peak, 334 [sic] miles.
319. 325 Winnemucca Depot. 334 miles.

321. 353 Advance of Civilization. End of Track, near Iron Point.
322. 354.0 Advance of Civilization. On Humboldt Desert.

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No. Miles Title Notes

325. 355.0 Car of Sup't of Construction. End of Track.
323. 355.0 Shoshone Indians, looking at Locomotive on Desert.
324. 355.0 Shoshone Indians. Humboldt Plains.
326. 395 Argenta Station. at Skull Ranch, 395 miles.
343. 396 Train at Argenta, 396 miles from Sac'to
327. 426.0 Chinese Camp, at End of Track
328. 428.0 Powder Bluff. West End of 10 mile Can.
329. 430 Second Crossing of Humboldt River. 430 miles.
330. 431.0 Commencement of a Snow Storm. Scene East of Second Crossing of Humboldt.
331. 432 Sentinel Rock. Ten Mile Canyon.
332. 432.5 Team Camp-Evening View, End of Track.
333. 433.0 Curving Iron. Ten mile Canyon.
335. 434.0 Building Water Tank., Trout Creek Mountains
334. 434.0 Humboldt Gate. Ten Mile Canyon.
341. 435 View across Canyon, from top of Palisades.
340. 435 Indian viewing R.R. from top of Palisades.
342. 435.0 Shoshone Indians. Ten Mile Canyon.
336. 435 Entering the Palisades, Ten Mile Canyon.
337. 435 The Palisades-10 Mile Canyon. 435 miles
338. 435 First Construction Train passing the Palisades, Ten Mile Canyon.
339. 435 Alcove in Palisades, Ten Mile Canyon.
345. 445 Carlin from the Water Tanks, Looking West.
344. 445 Machine Shops at Carlin. 445 miles.
347. 468 Elko from the West. 468 miles from Sac'to.
346. 468 Depot at Elko, 468 miles from Sacramento
348. 488 Water Tank at Peko. 488 miles from Sac'to.

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No. Miles Title Notes

349. 505 Scene near Deeth. Mount Halleck in dist.
353. 669 Poetry and Prose. Scene at Monument Point, North end Great Salt Lake.
352. 669 Salt Lake from Monument Point. 669 miles from Sacramento.
351. 669 Monument Point from the Lake.
350. 682 Railroad Camp near Victory. 10-1/4 miles laid in one day.
354. 690 The First Greeting of the Iron Horse. Promontory.
360. 690 The Last Act-690 Miles from Sacramento. Scene at Promontory.
359. 690 The Monarch from the East. Scene at Promontory point.
358. 690 The Monarch from the West. Scene at Promontory Point.
357. 690 The Rival Monarchs. Scene at Promontory Point.
355. 690 The Last Rail. The Invocation. Fixing the Wire.
356. 690 The Last Rail is Laid. Scene at Promontory Pt.
362. 740 Taylor's Mills, Wasatch. Near Ogden.
361. 740 Looking West from Taylor's Mills. Near Ogden.
364. 742 Railroad at Ogden. Wasatch Range in distance.
363. 742 Ogden and Wahsatch Range. 742 miles from Sacramento.

END OF SERIES

APPENDIX D

PUBLIC SOURCES

OF

ALFRED HART'S CPRR STEREO VIEWS

NOTES ON PUBLIC SOURCES LISTED FOR HART STEREOGRAPHS

All the negatives were taken by Hart, and if *published* by Hart are marked "H". Other publishers of Hart negatives are shown

as follows: D = Frank Durgan, L = Lawrence & Houseworth, P = Whitney & Paradise, and W = C.E. Watkins.

BANCROFT LIBRARY: Located on the Campus of the University of California at Berkeley. The stereographs can only be viewed at the reading room; photographic copies can be made by the library.

CROCKER ART MUSEUM: Located in Sacramento. Very cooperative staff, but visitor viewing of stereographs takes a lot of staff time. Best to use as back-up source. Copies by contractor to Museum. File numbers run from 1870.25 to 1870.242. There are some variations of same view.

CALIFORNIA STATE LIBRARY: Located in Sacramento: Filed in the California Room. Watkins and Hart stereographs housed separately. Full library facilities. Staff best informed on Hart and very cooperative. (viewing room, copy facilities, and some copy negatives already prepared).

HUNTINGTON LIBRARY: Located at San Marino, CA. Stereographs in Rare Book Department. Staff very cooperative with full facilities. Copy negatives of many stereos available. Collections viewed by appointment.

UNIVERSITY OF NEVADA LIBRARY: Located at Reno. Stereographs in Special Collections. Staff very knowledgeable and cooperative. Full facilities and some copy negatives on hand. The collection is, of course, strongest in views of northern Nevada.

LIBRARY OF CONGRESS: Located in Washington D.C. Stereographs are in Prints and Photographs Division. Majority of their collection was submitted for copyright purposes and is of exceptional quality. As one would expect from the world's largest library, full facilities available. Staff very helpful. Filed in Lot number 11477 and arranged by Hart's numbers.

NEW YORK PUBLIC LIBRARY: Fifth Avenue and 42nd St. New York City. Stereograph file numbers start with NYPG-92 F (108) or NYPG-92 F(102). Although only 53 Hart numbers are in the collection, some are very rare.. Full facilities and very helpful.

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*Stereographs in the following checklist marked * were copied for Appendix A. In lines where no asterisk appears, copies were made from the author's or unlisted collections.*

Where two letters are shown, they are not duplicates. They indicate one is a variant of the usual Hart view, or the title or mount is a variation. Lawrence & Houseworth stereographs shown are from the exact negatives published by Hart in his regular series. Although not included in this listing, large collections of single or half stereo prints from Hart negatives are located at the Stanford University Library, the Library of the Society of California Pioneers and the Huntington Library.

LOCATIONS OF HART RAILROAD STEREOS

BL=Bancroft Library, CAM=Crocker Art Museum, CSL=California State Library, HL=Huntington Library, UN= University of Nevada Library, LC= Library of Congress, NYL=New York Public Lib., PRIVATE COLLECTIONS: S=Barry A. Swackhamer Collection K=Author"s Collection

PUBLISHED BY: H= by Hart, W=by Watkins, P= by Whitney & Paradise, D= by Durgan, L= by Lawrence & Houseworth

VIEWS MARKED WITH AN ASTERISK ARE USED IN APPENDIX A

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K
1.	-	H	-	H	-	-	-	W	H
2.	-	-	-	W	H	-	-	-	W	H
3.	-	H	-	H	-	-	-	H	HW

4.	*H*	*H*	*H*	*H*	-	*H*	-	*W*	*W*
5.	-	*H*	*H*	*H*	-	*H*	-	*W*	*H*
6.	-	-	*H**	*H*	-	*H*	*W*	*P*	*W*
7.	-	*H*	*H*	*H*	-	*H*	-	-	*W*
8.	-	*H*	*H*	*H*	-	*H*	-	*H*	*W*
9.	-	-	*HW*	*H*	-	*H*	*W*	*W*	*HD*
10.	-	-	*H*	*H*	-	*H*	-	*H*	*H*
11.	-	*H*	*H*	*H*	-	-	-	*W*	*W*
12.	*H*	-	*H*	*H*	-	-	*HW*	*W*	*HW*
13.	-	-	-	*H*	-	-	-	*P*	*W*
14.	*H*	-	-	*H*	-	-	-	*WP*	*H*
15.	-	*H*	*H*	*H*	-	*H*	-	*P*	*H*
16.	-	*H*	*H*	*H*	-	*H*	-	*P*	*H*
17.	-	-	*H*	-	-	-	-	*P*	*H*
18.	-	*H*	*H*	*H*	-	*H*	-	*P*	*HP*
19.	-	*H*	*H*	*H*	-	-	-	*P*	*P*
20.	-	-	*H*	*H*	-	*H*	-	*P*	*H*
21.	-	*H*	*H*	*H*	-	-	-	*W*	*H*
22.	-	*H*	*HW*	*H*	-	*H*	*W*	*P*	*H*
23.	-	*H*	-	*H*	-	-	-	*P*	*P*
24.	-	*H*	*H*	*H*	-	*H*	-	*P*	*HW*
25.	-	*H*	*HW*	*H*	-	-	-	*HP*	*W*

Hart No.	*BL*	*CAM*	*CSL*	*HL*	*UN*	*LC*	*NYL*	*S*	*K*
26.	-	-	-	-	-	-	-	*P*	*H*

LOCATIONS OF HART RAILROAD STEREOS

Hart No.	*BL*	*CAM*	*CSL*	*HL*	*UN*	*LC*	*NYL*	*S*	*K*
51.	-	*H*	-	*H*	-	*H*	*W*	*W*	*H*
52.	-	*H*	*H*	*H*	-	-	*W*	*W*	*H*
53.	-	*H*	*H*	*H*	-	*H*	-	*W*	*H*
54.	*H*	*H*	*H**	*H*	-	-	-	*W*	*H*
55.	-	*H*	*H*	*H*	-	*H*	-	*H*	*H*
56.	*H*	-	-	*H*	-	-	-	*H*	*H*
57.	-	-	-	*H*	-	-	-	*W*	*H*
58.	-	*H*	*H*	*H*	-	*H*	-	*H*	*W*
59.	-	-	*H*	*H*	-	*H*	-	*W*	*H*
60.	-	-	-	*H*	-	-	-	*H*	*H*

27.	-	*H*	*H*	-	-	-	-	*HP*	*HP*
28.	-	-	-	*H*	-	-	*W*	*P*	*W*
29.	-	-	*H*	*H*	-	*H*	-	*HP*	*H*
30.	-	*H*	*H*	*H*	-	-	-	*HP*	*H*
31.	-	*H*	-	*H*	-	-	-	*P*	*HW*
32.	-	*H*	-	*H*	-	-	-	*HP*	*HD*
33.	-	*H*	-	*H*	-	-	-	*H*	*H*
34.	-	*H**	-	*H*	-	-	-	-	*H-*
35.	-	*H*	*H*	*H*	-	-	-	*H*	*H*
36.	*H*	*H*	*H**	*HW*	-	-	-	*H*	*H*
37.	-	*H*	-	*H*	-	-	-	-	*W*
38.	-	*H*	*H*	*H*	-	-	-	*W*	*H*
39.	-	*H*	-	*H*	-	*H*	-	*W*	*W*
40.	-	-	*H*	-	-	*H*	-	*H*	*H*
41.	*H*	*H*	*HW*	-	-	-	*H*	*H*	*HD*
42.	-	-	*H*	*H*	-	-	-	*H*	*W*
43.	*H*	-	*H*	*H*	-	*H*	*W*	*HW*	*H*
44.	*H*	-	*HW*	*W*	-	-	*W*	*HW*	*H*
45.	-	*H*	*H*	*H*	-	-	-	*H*	*H*
46.	-	-	*H*	-	-	*H*	-	*H*	*W*
47.	*H*	*H*	*HW*	*H*	-	-	-	*H*	*H*
48.	*H*	-	*H*	*H*	-	*H*	*W*	*W*	*WD*
49.	-	*H*	-	*H*	-	-	-	*H*	*W*
50.	-	*H*	*H*	*H*	-	-	-	*H*	*H*
61.	*H*	-	*H*	*W*	-	*H*	*W*	*H*	*HH*
62.	-	*H*	*H*	*H*	-	*H*	-	*H*	*W*
63.	-	*H*	*H*	*H*	-	*H*	-	*HH*	*HH*
64.	-	-	*H*	*H*	-	-	*W*	*H*	*H*
65.	-	-	*H*	-	-	-	*W*	*H*	*H*
66.	-	*H*	*H*	*H*	-	*H*	-	*W*	*H*
67.	-	*H*	*H*	*H*	-	-	-	*H*	*H*
68.	-	*H*	*H*	*H*	-	*H*	-	*H*	*H*
69.	-	-	*H**	*H*	-	-	-	*H*	*H*
70.	-	*H*	*H*	*H*	-	*H*	-	*H*	*H*
71.	*H*	*H*	*H*	*H*	-	-	-	*H*	*H*

72.	-	-	W	H	-	H	-	W	H
73.	-	-	HW	H	-	H	W	H	H
74.	-	H	H	H	-	-	HW	W	W
75.	-	-	H	H	-	-	-	H	W

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K
76.	-	H	-	W	-	H	H	HW	H
77.	-	-	H	H	-	H	W	H	H
78.	-	-	H	H	-	H	-	W	W
79.	-	H	-	H	-	H	-	H	HH
80.	-	-	H	H	-	-	-	HW	H
81.	-	-	H	H	-	H	-	W	H
82.	H	H	H	-	-	H	-	H	H
83.	-	H	H	H	-	-	-	-	H
84.	-	H	-	H	-	-	W	-	W
85.	H	H	-	H	-	H	-	H	H
86.		-	H*	W	W	-	H	H	H-
87.		H	H	H	H	-	H	H	W
88.	H	H	H	H	-	-	-	HW	H
89.	-	-	H	W	-	H	-	W	HD
90.	-	H	H	H	-	-	-	H	H
91.	-	-	H	H	-	H	-	H	H
92.	-	H*	HW	H	-	-	-	H	H
93.	-	-	H	W	-	H	H	H	H
94.	-	H	H	H	-	H	-	H	H
95.	-	H	H	H	-	H	-	W	H
96.	H	-	H	H	-	-	-	W	H
97.	-	-	H	H	-	H	-	H	H
98.	H	H	H*	H	-	H	W	HW	H
99.	H	H	H	H	-	-	-	H	H
100.	H	-	H	H	-	-	-	H	HH

LOCATIONS OF HART RAILROAD STEREOS

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K
101.	-	-	H	H	-	H	-	H	W
102.	-	-	H	HH	-	H	-	-	H
103.	-	-	-	H	-	H	-	-	H
104.	-	H	H	H	-	H	-	W	W
105.	-	-	-	H*	-	-	-	-	H
106.	-	H	H	H	-	H	-	H	H
107.	-	H	H	H	-	-	-	H	H
108.	-	-	H	H	-	-	-	H	H
109.	H	-	H	W	-	H	-	W	HH
110.	-	-	H	H	-	H	-	H	H
111.	-	-	H	H	-	H	W	HW	H
112.	-	-	H	H	-	-	-	H	H
113.	-	-	H	H	-	H	-	WH	H
114.	-	H	H	H	-	-	-	H	H
115.	-	H	-	H	-	H	-	H	H
116.	-	H	H*	H	-	H	-	-	H
117.	-	-	H	H	-	-	-	H	H
118.	-	-	H	H	-	H	-	H	H
119.	-	H	H*	W	-	H	-	-	D
120.	-	-	H	H	-	-	-	H	H
121.	-	-	H	H	-	H	W	H	H
122.	-	H	-	H	-	H	-	W	H
123.	-	H	-	H	-	H	-	W	HW
124.	-	H	H	H	-	-	-	H	H
125.	-	-	-	-	-	-	W	W	H

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K
126. -	H	H	H	-	H	-	W	H	
127.	-	-	H	H	-	H	-	W	HW
128.	-	-	H	H	-	-	-	W	HH
129.	-	H	H	W	-	-	W	W	HW
130.	H	-	H	W	-	H	WW	W	H
131.	-	H	H	H	-	H	W	H	HH
132.	-	-	H	-	-	-	-	HW	H
133.	-	H	W	W	H	-	-	HW	W
134.	-	H	-	H	-	-	-	L	H
135.	-	-	H*	H	-	-	-	H	H

136.	H	H	-	H	-	-	H	H	H
137.	-	H	-	H	-	-	-	H	H
138.	H	H	-	H	-	-	-	W	HW
139.	-	-	-	H	-	-	-	D	HL
140.	-	-	-	-	-	-	-	L	H
141.	H	H	H	H	-	H	-	H	H
142.	-	-	-	H	-	-	-	H	H
143.	-	H	-	H	-	-	-	-	L
144.	-	-	-	H	-	-	-	L	H
145.	-	H*	-	H	-	-	-	L	H
146.	-	H	-	H	-	-	-	H	H
147.	-	H	-	H	-	-	-	-	H
148.	-	H	-	H	-	-	-	H	H
149.	-	H	-	H	-	H	-	W	H
150.	-	H	-	H	-	-	H	D	H

LOCATIONS OF HART RAILROAD STEREOS

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K
151.	-	H	-	HW	-	H	W	H	H
152.	-	-	-	H	-	-	-	H	H
153.	-	-	-	W	-	H	-	HW	HH
154.	-	-	H	H	-	H	W	H	H
155.	-	H	-	W	-	-	-	H	H
156.	-	H	W	H	-	H	-	H	H
157.	-	H	-	H	-	-	-	H	H
158.	H	-	-	H	-	-	-	HW	H
159.	-	H	H	H	-	H	-	W	H
160.	-	H	W	H	-	-	-	H	H
161.	-	H	-	H	-	-	-	H	H
162.	-	H	-	H	-	-	-	H	HH
163.	-	-	H	H	-	-	H	W	H
164.	-	H	H	H	-	-	-	W	HW
165.	-	-	-	H	-	-	-	-	W
166.	-	-	H	H	-	-	-	HH	HW
167.	-	H	H	H	-	-	-	H	W
168.	-	H	W	H	-	-	-	H	H
169.	-	H	-	H	-	-	-	H	W
170.	-	H	-	H	-	-	-	H	W
171.	-	-	-	H	-	-	-	H	H
172.	-	H	-	H	-	H	-	H*	H
173.	-	H	H	H	-	H	W	W	H
174.	-	H	-	H	-	H	-	W	H
175.	-	-	W	H	-	-	-	W	HW

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K	
176.	-	H	-	H	-	H	-	W	H	
177.	-	H	-	H	-	-	-	H	H	
178.	-	H	-	H	-	H	-	H	H	
179.	H	-	H	H	-	H	-	H	H	
180.	H	-	-	H	-	H	-	H	HH	
181.	-	H	-	H	-	-	-	HH	H	
182.	-	H*	-	H	-	-	-	-	H	
183.	-	-	-	H	-	-	H	HH*	H	
184.	-	H	-	H	-	H	-	HW	HW	
185.	H	H	H	H	-	-	-	HH	H	
186.	-	H	-	H	-	-	-	W	H	
187.	-	-	W	H	-	H	HW	W	H	
188.	-	-	-	H	-	H	-	W	HH	
189.	-	-	W	H	-	H	-	H	HW	
190.	-	-	W	H	-	H	-	W	H	
191.	H	H	-	H	-	H	-	H	H	
192.	-	H	-	H	-	H	-	H	W	
193.	-	-	-	-	-	-	-	H*	H	
194.	-	-	W	H	-	-	-	W	W	
195.	-	-	-	H	-	H	-	H	H	
196.	-	H	-	H	-	-	-	H	HW	
197.	-	H	-	H	-	-	-	H	H	
198.	-	-	-	H	-	H	-	H	H	
199.	-	H	W	H	-	H	-	H	HH	
200.	-	H	-	-	-	H	-	H	HW	

LOCATIONS OF HART RAILROAD STEREOS

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K	
201.	-	H	-	H	-	H	-	H	H	
202.	-	H	-	H	-	H	-	W	H	
203.	-	H	-	H	-	H	HW	H	HW	
204.	-	-	W	H	-	H	-	H	H	
205.	-	-	-	H	-	-	-	W	H	
206.	-	H	W	H	-	H	-	H	H	
207.	-	H	W	W	-	H	HW	W	HD	
208.	-	-	-	W	-	-	-	-	H	
209.	H	H	-	H	-	H	-	H	H	
210.	H	-	H	H	-	-	-	H	HW	
211.	-	-	-	H	-	-	-	H	DH	
212.	-	-	-	H	-	-	-	H	HW	
213.	H	-	H	-	-	-	W	W	HW	
214.	-	H	-	H	-	-	HW	W	H	
215.	-	-	H	H	-	H	-	-	H	
216.	-	H	-	H	-	H	-	W	H	
217.	-	-	-	H	-	-	-	H	HH	
218.	-	-	H	H	-	H	-	W	HW	
219.	-	-	-	-	-	-	-	-	H	
220	-	H	-	H	-	-	-	W	H	
221.	-	H	H	H	-	H	W	H	H	
222.	-	-	-	H	-	-	-	W	H	
223.	-	H	-	H	-	H	-	H	H	
224.	-	H	H	-	-	-	-	H	H	
225.	-	H	-	H	-	-	W	H	H	

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K	
226.	-	H	W*	H	-	-	-	HH	H	
227.	-	-	-	H	-	H	-	H	H	
228.	-	H	-	H	-	-	-	H	H	
229.	H	H	-	H	-	H	-	HH	H	
230.	-	-	-	-	-	H	-	HH	H	
231.	-	-	W	-	-	H	W	H	H	
232.	-	H	H*	H	-	H	-	W	H	
233.	-	H	H*	H	-	-	-	H	H	
234.	-	-	H	H	-	-	-	HD	H	
235.	-	H	-	H	-	-	-	H	H	
236.	-	-	-	H	-	H	W	W	HW	
237.	-	-	-	H	-	H	-	H	H	
238.	-	H	-	H	-	H	W	W	HW	
239.	-	-	-	H	-	H	-	W	HW	
240.	-	H	H	H	-	-	-	H	H	
241.	H	H*	-	H	-	-	-	H	H	
242.	-	H	-	H	-	H	-	H*	H	
243.	-	H	-	H	-	-	-	-	W	
244.	-	-	-	H	-	H	-	W	H	
245.	-	H*	-	H	-	H	-	H	-	
246.	-	-	-	-	-	H	-	HD	HD	
247.	H	-	-	H	-	H	-	D	HD	
248.	-	H	W	H	-	-	W	H	HH	
249.	-	H	-	H	-	H	-	W	H	
250.	-	-	-	H	-	-	-	HD	H	

LOCATIONS OF HART RAILROAD STEREOS

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K	
251.	-	-	-	H	-	-	-	HD	H	
252.	-	-	W	H	-	H	W	H	HW	
253.	-	H	-	-	-	H	-	W*	W	
254.	-	H*	-	H	-	H	-	H	W	
255.	H	-	-	H	-	H	W	W	H	
256.	-	-	-	H	-	H	W	H	H	
257.	H	-	H	H	-	H	W	W	H	
258.	H	-	-	H	-	H	W	HH	HH	
259.	H	-	-	H	-	H	-	-	W-	
260.	-	H	-	H	-	-	W	W	W	

261.	-	-	-	-	-	H	W	W	H
262.	H	H*	-	H	-	-	-	H	H
263.	H	-	-	H	W	-	-	H	H
264.	H	-	-	H	-	H	W	H*	H
265.	H	H	-	H	-	-	-	H	W
266.	-	-	-	H	-	-	-	HH	H
267.	-	H	-	H	-	H	-	W	H
268.	H	-	-	H	-	-	-	H*	H
269.	-	-	-	H	-	H	-	H	W
270.	-	H	-	H	-	H	-	H	H
271.	-	-	-	H	-	H	-	H	H
272.	H	H*	-	H	H	H	-	H	W
273.	-	H	-	H	H	H	-	H	H
274.	-	-	W	H	-	-	-	W	WH
275.	-	-	-	H	H	H	W	H	W

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K
276.	-	-	-	H	-	H	-	H	H
277.	H	H	-	H	H,H	-	-	W	H
278.	-	-	-	H	-	-	-	-	W
279.	-	-	-	H	H	H	H	HW	H
280.	-	H*	-	H	W	H	-	-	W
281.	-	-	-	H	-	H	-	W	HW
282.	-	-	-	H	H	-	-	W	HW
283.	-	-	-	H	W	-	W	W	H
284.	-	H	-	H	HW	-	-	-	W
285.	-	-	-	H	-	-	-	H	W
286.	H	-	-	H	H	-	-	H*	H
287.	-	H	-	H	-	-	-	H	H
288.	-	-	-	H	H	H	-	-	H
289.	-	-	-	H	-	H	-	H	HW
290.	-	-	-	H	H	-	-	W	H
291.	-	-	-	H	H,	H	-	-	H
292.	-	H	-	H	H	H	-	-	W
293.	-	H*	-	H	H	-	-	-	H
294.	-	H	-	H	-	H	-	W	H
295.	-	-	-	H	-	H	-	H*	H
296.	-	-	-	H	H	-	H	W	H
297.	-	-	-	H	H	-	-	W*	H
298.	-	H*	-	H	H-	-	-	H	
299.	-	H	-	H	HH	H	HW	H	HH
300.	-	H	-	H	H	H	W	H	H

LOCATIONS OF HART RAILROAD STEREOS

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K
301.	-	H	-	-	W	H	HW	H	W
302.	-	-	-	-	WW	H	HW	W	HW
303.	-	H	-	W	H	H	-	-	W
304.	-	-	-	HW	HW	H	-	HW	HW
305.	H	H	-	W	W	H	W	W*	H
306.	-	H	-	H	WW	H	-	H	H
307.	-	-	-	-	-	H*	-	-	W
308.	-	H*	-	H	H	-	-	-	W
309.	-	H*	-	-	-	-	-	-	WW
310.	-	H	-	-	H	H	-	-	W
311.	-	H	-	-	-	H	-	H	H
312.	-	-	-	W	H	-	-	H	H
313.	-	H*	W	H	H	H	-	-	H
314.	-	H	-	H	-	-	-	W*	W
315.	-	-	W	H	W	H	-	W	WW
316.	-	H	-	H	-	H	-	HW	H
317.	H	H	-	H	H	H	-	H	W
318.	-	H*	-	W	-	H	-	W	H
319.	-	H	-	-	W	-	-	W	H
320.	-	-	-	-	H	H	H	W	H
321.	-	-	W	H	-	H	W	W	HW
322.	-	H	W	H	H	H	-	W	H
323.	-	-	-	-	-	-	W	-	W
324.	-	-	-	-	HW	-	-	W	W
325.	-	-	-	H	-	-	-	H*	H

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K	
326.	-	H	W*	W	-	-	-	W	W	
327.	-	-	-	H	-	-	-	W*	H	
328.	-	-	-	-	W	H	-	H	W	
329.	-	H*	-	W	W	-	-	-	H	
330.	-	-	W	H	W	H	-	H	H	
331.	-	H*	-	H	W	-	-	H	H	
332.	-	H	W*	H	-	-	-	W	H	
333.	-	-	-	-	H	-	-	H*	H	
334.	-	-	W	W	W	H	-	H	H	
335.	-	-	-	-	H*	H	-	-	W	
336.	-	-	-	-	WW	H	-	W	H	
337.	-	-	-	H	-	-	-	-	H	
338.	H	H	-	H	H	-	W	W	H	
339.	-	H	W	H	H	H	W	W	HW	
340.	-	-	-	HH	HHW	H	-	HH	H	
341.	-	H	-	H	W	H	W	H	H	
342.	-	-	H-	H	HW	-	W	W	H	
343.	-	-	-	-	W*	-	-	-	H	
344.	-	-	-	-	-	-	-	W*	H	
345.	-	H	-	-	W	-	-	H	H	
346.	-	-	-	-	-	H	-	--	W	
347.	-	H	-	H	-	-	-	W	W	
348.	-	H*	-	-	H	-	-	-	W	
349.	-	-	-	-	-	H	-	W*	W	
350.	-	H*	-	-	-	-	-	H	H	

LOCATIONS OF HART RAILROAD STEREOS

Hart No.	BL	CAM	CSL	HL	UN	LC	NYL	S	K	
351.	-	-	-	H	-	-	-	W	W	
352.	-	-	-	-	-	H	-	W	W	
353.	-	H	-	W	-	H	-	HW	WW	
354.	-	H*	-	-	-	-	-	H	-	
355.	-	-	W	H	-	H	-	H	WW	
356.	H	-	-	H	-	-	-	H	W	
357.	-	-	-	H	-	-	-	H	H	
358.	-SPRR copy now in UP museum							-	-	-
-										
359.	-	H*	-	-	-	-	-	-	-	
360.	-	H*	-	HW	-	-	-	H	HW	
361.	-	H*	W	H	-	-	-	-	W	
362.	-	H*	-	-	-	H	-	-	-	
363.	-	-	W	W	-	-	H	W	H	
364.	-	-	-	-	-	H	-	W*	H -	
totals	53	192	156	322	54	181	69	319	359	

❊ ***END OF SOURCE LIST*** ❊

APPENDIX E

GLENN WILLUMSON'S ARTICLE ON HART

ALFRED HART: PHOTOGRAPHER OF THE CENTRAL PACIFIC RAILROAD

BY

GLENN L. WILLUMSON

History of Photography (London),
(January/March, 1988), Volume 12, No. 1, pp. 61-75.
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APPENDIX F

TRANSPOSING AND SOME STEREO-CAMERA DETAILS

TRANSPOSING, STEREO CAMERA DETAILS, and DARK TENTS

To achieve the correct perception of depth in stereo photography, objects which are closer must have a smaller optical spacing than those that are in the distance. If one holds up a pencil at arms length, it will appear to move to the left against the background when viewed with the right eye alone and to the right when viewed with the left eye alone. With both eyes open the pencil appears closer than the background because the images sent to the eyes by the pencil have been displaced inward and therefore are gauged closer than images received from objects in the background. The images received from the two prints on a stereo-card must duplicate this for depth to be perceived. The remarkably small changes in the converging angle for human eyes at various distances, were set down in a table by one of the earliest writers on the theory of stereo photography. He calculated that at 100 feet the angle was nine hundredths of a degree from parallel and at 1000 feet the angle was nine thousandths of a degree.[146]

146. A. Claudet, *Du StOreoscope et de ses Applications a la Photographie* (Paris: Novembre 1853) p. 31. Some of the other distances and angles of convergence for eyes 2-1/2 inches apart are: 1 foot = 9°, 2 feet = 4.5°, 3 feet= 3°, 5 feet = 1.8° and 10 feet 0.9°. Using the modern table of tangents in a scientific calculator, the angles and distances shown require an eye spacing of only 1-7/8 inches, however, despite this error the table still illustrates the reduction of convergence with distance.

At the image plane on the negative, inside a camera, the image was inverted, and the left and right orientations were reversed. In Hart's wet-plate camera the same orientation change occurred, but was reversed in the positive print made by passing light through the back of the glass negative to sensitized paper pressed against the emulsion side of the negative. The same effect could be obtained by inverting the negative while keeping the back toward the observer, except that the blacks and whites were not reversed as in the positive print. For an ordinary camera with a single lens, turning the negative and making a print solved the problem of image inversion by the lens.

With a *stereo* camera having two lenses and a single long negative, closer objects were shifted to the left by the left lens and to the right with the right one. This was the result of the left/right reversal by each lens, and it caused near objects to be more widely separated on the negative than objects in the background. This was the exact opposite of the requirement for depth to be correctly perceived. If a contact print was made of the entire stereo negative containing both images, the inversion problem was separately corrected in each image. Unfortunately the optical spacing was not changed and the

images of an object in the foreground still had greater optical spacing on the finished print. If the two separate pictures on the print were cut apart and their positions reversed, the optical spacing problem was solved. In the uncut print the image of a foreground object was shifted left in the left picture. After cutting and relocating, the former left picture became the right one and the left shift of the foreground object moved it closer to the centerline of the newly arranged pair of prints. The same inward shift occurred in the former right print. These cut and switched prints were said to have been *transposed*.

(Fig. 81) Sloping 2 x 4, as seen on the ground glass of the camera and the developed negative. Small rod with sign is 7-1/2 feet from camera, and background wall is 25 feet, (MBK photos,5/20/95)

(Fig. 82) Uncut print from the above. Note that the far ends of the 2 x 4 seem *closer* than the part in the foreground. Also the sign in the foreground is shifted to the right in right image with respect to the background. Taken with wet-plate stereo camera.

(Fig. 83) Images cut and transposed for viewing.

The transposed prints were then glued to a mounting card, yielding a stereograph with reduced optical spacing of foreground objects in relation to distant objects and allowing the viewer to perceive depth. Even if the left and right negative images are masked so that only a portion of each is printed, the resulting prints will yield a three-dimensional view if they are transposed.

Although Hart did not place dark borders around the individual images on his stereographs, they sometimes were used in illustrations in books and stereographs by other makers. If such borders were used, when observed through a viewer, they gave the impression of a scene in a window. Unless the optical spacing of the border was equal to or less than the optical spacing of the nearest objects in the stereo view, the closer objects would appear to be projecting forward out of the window.

The problems associated with transposing are discussed in more detail in a number of publications of the Carl Zeiss Company at Jena before World War II, and afterward by Zeiss-Ikon, Stuttgart.

Several illustrations on this subject appear in an article on the Stereotar C lens for their 1950s Contax 35m/m camera.[147] The firm of Carl Zeiss having been making microscopes since 1846 and photographic objectives since the 1890s, is precise, scholarly, and absolutely undaunted by optical complications. In the 1930s, they attacked the problem of transposing stereo images by optical means in both viewers and projection devices. They produced a number of successful solutions, and their researchers had previously invented a device for optically transposing prints on either glass or paper.

In 1927, Zeiss-Ikon, the camera and equipment-making subsidiary of Carl Zeiss A.G., advertised Stereo-Umkehrapparat (Stereo inverting apparatus) accommodating four sizes of stereo negatives.[148] An example of the 4.5 x 10.7 cm. size with serial number 79395 is in the California Museum of Photography at Riverside, California. It is a fixed focus, twin lens, stereo box camera set for one-to-one reproduction; that is the distance from the negative to the lens is the same as the distance from the lens to the positive print. The shutter is a sliding metal plate with two holes spaced like the lenses, and the aperture is controlled by sliding another metal plate with two different sized sets of holes. In use, a negative is placed at one end and an unexposed positive of the same size at the other. When the negative end is exposed to light and the "shutter" is opened, each image is re-inverted separately on the positive, giving a perfectly correct stereo print with the left negative image on the left. Being Zeiss, German, and never about to drop a great idea, they also offered as the next item, "Stereo-Umkehr-und Verkleinerungsapparat" which both optically transposed and reduced larger negatives to the more

147. Dr. Otto Vierling, *Stereophotographie mit der Contax, der Contaяex und der Contina* (Stuttgart: Photographie und Forschung (research), Hausmitteilung der Zeiss-Ikon A.G., 1957) Band 7, p. 198.

148. Zeiss-Ikon A.G., *Catalog* (in German for Switzerland) *Liste C 219* (Dresden: Zeiss Ikon, 1 March 1927) p. 57. Catalog numbers 629/2 for 9 x 18 cm., 629/3 for 8 x 16 cm, 629/4 for 6 x 13 cm. and 629/5 for 4.5 x 10.7 cm. stereo negatives.

popular 4.5 x 10.7 and
6 x 13 cm. sizes.

(Fig. 84) Zeiss optical transposing apparatus from Zeiss- Ikon's first (1927) Swiss catalog, p. 57.

In Hart's day it would have been perfectly possible to optically transpose negatives by re-photographing them with a long bellows stereo camera and contact printing the resulting transparent positive to yield a transposed negative ready for printing. Reduction or enlargement as well as masking would have been possible in this process, but a contemporary description has not surfaced. If an uncut, but transposed negative is discovered, it would have to include reduction or enlargement from a known original to *prove* optical transposition of the *negative*.
Europeans favored transparent glass stereographs and, because of the greater difficulty of cutting and mounting the transparent positives of this material, they appear to have used other methods to handle the problem of left/right exchange. One was the Transposing Frame, a box 150 percent of the length of the negative with a window in the center of one side. The glass negative and the sensitized glass for the positive were placed inside, the negative against the left end and the positive against the right, leaving one half of each under the window. The window was exposed to white light, the box opened in safe (dim yellow or red) light, both the negative and positive moved to the opposite ends, and a second exposure made.
If that sounds tedious, the operator also had to remember to put the positive in, emulsion-side up, the negative on top with emulsion-side down, and to lift the negative while switching ends to avoid scratching the emulsion. Transposing frames can also be used to produce paper prints. If mounted on a stereo card, such prints can be easily detected because they are not cut down the center.
Since Hart always used separately mounted prints on his stereographs there is no evidence that he used a transposing frame, but in later years the Keystone View Company of Meadville, Pennsylvania, appear to have used a transposing frame with an oversize window (bits of the adjoining image show at the edges) to make transposed proofs of their negatives.[149]

NEGATIVE AND LENS SIZES

The five by eight inch format which Hart appears to have used for his stereo negatives, was an American size not mentioned in most contemporary European publications. While not directly related to Hart's railroad work, in earlier days as a daguerreotype photographer he would have used plates derived from a size (6-1/2 x 8-1/2 inches or 16.5 x 21.5 cm.) introduced for the first commercially produced cameras in 1839.
A summary of the negative sizes and the focal lengths of the associated lenses commonly seen in the 1860s appears below with a similar table of modern sizes and focal lengths provided for comparison.

As indicated in the table under "Usual focal length in inches," the normal lenses in the very early days of photography followed the general rule that for the smallest sizes, the focal length was about equal to the diagonal of the negative and for negatives larger than Sixth Plate the focal lengths were progressively shorter than the diagonal. There are a huge number of focal lengths available for modern cameras (from 8 mm to 1000 mm for the 35 mm format alone), and individual

149. The California Museum of Photography at Riverside, California, now owns the stereo negatives and archives of the Keystone View Company including thousands of proof prints. The transposition of the prints is evidenced by a small amount of the adjacent image being printed at the left and right ends of many of the proof prints. The portions of the negative meant to be printed at the center of the finished stereograph are frequently marked at the bottom with a small "x." That is the left edge of the right image in the final stereo proof and the right edge of the left image are so marked.

tastes vary in this matter, making the exact focal length of the *normal* lens hard to define.

The focal lengths given in the modern table are those either supplied with the camera or frequently recommended by experienced photographers. The modern format/normal focal length ratios are not very different from those of 150 years ago. The normal (or usual) focal length lens provided an angle of view that a majority of photographers found most useful. That is, if they were only allowed one lens for their camera, that was the one they would select.

With only a single available lens, if one wished to increase the size of the image of an object on the ground glass--they moved closer; and to include more of a scene or increase the coverage--they moved back. Unfortunately, situations arose where moving the camera back and forth was impossible. Inside a room or tunnel, one was limited by the walls, and for sweeping landscapes, a wide angle lens was needed. Conversely when photographing a train from across a canyon, or workers on a trestle high above, the camera could not be moved closer and a long or telephoto lens was required to give an image of the subject which was large enough for contact printing.

For his stereographs Hart was limited to a final print size of about 3 inches square, and changing to longer or shorter lenses was his only solution in the stereo format, but in single lens photography he could get a wide angle effect by changing his negative format. As shown earlier (Fig. 60), by removing the lens shades, the lenses available in Hart's time would cover a seven inch working circle.

This would permit the use of a 6.25-by-3 inch negative area, and in Hart No. 2(a) the print is a panorama of the trestle at Newcastle measuring 6.1-by-3.05 inches. The more usual way of adjusting the angle of coverage to wide angle was to leave the negative size unchanged and use a lens of shorter focal length. Changing the focal length of the lens also modified the perspective because a wide angle or short lens made close objects appear larger, and gave the impression of a relatively large separation between foreground and background. A long or telephoto lens enlarged the relative size of distant objects while giving the impression of a smaller depth to the whole scene. A clear example of the use of long and short lenses are in Figs. 62 and 63 where Hart photographed the locomotive HUNTINGTON on the narrow track around Cape Horn. Again in Appendix A Nos. 109 and 109(a) the rock in the foreground remains about the same size, while the mountains loom up in the telephoto view.

THE PORTABLE DARK TENT

This description is taken from a book on photography published in 1867: [150]

"Leake's Portable Dark Tent / This convenient appendage to the photographer's 'kit' consists mainly of a rectangular chamber, 30 inches high, 29-1/2 inches long, 20-3/4 inches wide, the top and bottom of which are of wood, and the four sides of yellow and black calico. The front is provided with extra folds of calico, united by an elastic band which stretches sufficiently to admit the head and shoulders of the operator, and the light is prevented from entering by the contraction of the band around the waist. The interior of a chamber of the above dimension affords convenient space for working any size plates up to 10 x 12, and light (non-actinic)[151] is admitted thereto through a yellow silk window let into the back for that purpose. The calico sides of this tent are kept distended by means of hinged stretchers; and when it is desired to fold the tent, these are pulled away from the top, against the wedged portion of which they are jammed, and the whole then closes up to a box having the same length and breadth as given above, but only 4-1/2 inches deep. A tripod of the ordinary form is furnished with the above, as well as strong leather straps and handle to go around the tent."

One can imagine what it was like working inside that space on a hot day with the fumes of alcohol, ether, developer and hypo.

DUPLICATING PIONEER PHOTOGRAPHIC METHODS

Some of the processes described in Van Monckhoven's

150. D. Van Monckhoven, *A Popular Treatise on Photography*, p. 129.

151. "Actinic light" meant here light which had the color and intensity to cause a photographic reaction. Dim yellow or red light was "non-actinic."

text are relatively easy to duplicate, and a few have been tried in preparing this appendix. Preparing salted printing paper, its exposure to the sun and subsequent fixing are described in meticulous detail on pp. 99-112 of his book. Following these instructions in 1994, a few sheets of ordinary typing paper were sensitized directly (that is without using albumin) and produced quite good sepia prints with an exposure in the hot Sacramento sun of fifteen minutes rather than the hours mentioned for exposure in England. To obtain black prints an exposure of fifty minutes was sufficient. As advised in the 1867 book, the hypo did markedly reduce the density of the image from its appearance when taken out of the printing frame.
In an attempt to obtain a glossy surface without going to the kitchen to make salted albumin, some unexposed modern photographic paper was treated in hypo to remove the silver compounds and then washed for an hour to remove the hypo and hopefully everything else used to sensitize the emulsion.

The sheet was then dried and floated on a solution of pure NaCl (table salt without iodine could also have been used) and sensitized by floating on a 20 percent silver nitrate solution. When exposed to sunlight for about fifteen minutes the print turned almost blood red, and did not change color after two hours of exposure, but fixing with hypo changed the color an orange tone, and did reduce the density slightly. Modern experiments with the photographic techniques used by Alfred Hart, even the safe and simple ones like making salted paper, and none of the more dangerous ones like adding ether and alcohol to depleted collodion, reinforce respect for the fine results he obtained. An 1863 admonition in the matter of dangerous photographic solutions by a contemporary of Hart's, Charles Waldack is repeated below:

> We have often been struck with the carelessness of photographers, in not guarding against accident with poisonous chemicals, and give the following as a warning:
>
> A boy of about two years of age was taken by a servant into a photographer's room at Huddersfield (England), and whilst the girl was sitting for her portrait, the child got hold of an uncorked bottle containing cyanide of potassium, and drank such a quantity that he died in two hours afterwards.[152]

Because he could inspect (by dim yellow light) every step of the process from negative sensitizing through the final development of the print, Hart had some added control, but the basic inconvenience of photography in his day must have been simply overwhelming to all but its most dedicated practitioners. Historians will forever be thankful he and his contemporaries persevered.

152. *American Almanac of Photography for 1863,* Charles Waldack, (Cincinnati, Ohio: Peter Smith, 36 West Fifth Street), p. 62. This book also contains directions for preparing many photographic solutions and 13 advertisements for photographic equipment.

(Fig. 85) Alfred Hart, No. 185. *Depots at Cisco*. The rails reached Cisco, 92 miles from Sacramento, on November 29, 1866, and it remained the end-of-track for about a year while the summit tunnels were being completed. Freight wagons for the Comstock mines and the railroad were loaded at the long shed at the left. Passengers and Wells Fargo stage coaches used the double building up the hill from the freight shed. The main line is in the foreground and curved right to pass next to the passenger depot.

(Fig. 86) August 1991, Cisco looking northeast as in Hart No. 185. There were too many trees to take a picture from Hart's exact location, but the direction and site are identical. The passenger depot was just below the small shack above the main line, and the all-important turntable was located in the bushes at the right center. Trees 20 to 30 feet high cover the location of the freight shed at the left. The siding below the main line remained into the 1950s.

APPENDIX G

REPLICAS OF SOME PAGES

OF

THE TRAVELER'S OWN BOOK

BY

ALFRED A. HART

NOTES ON APPENDIX G

1. Only a few copies of Hart's *The Traveler's Own Book* exist in libraries and these illustrations are printed from a microfilm kindly supplied by The Bancroft Library at the University of California, Berkeley. Their copy is in quite good condition, measures about 4 inches by 6 inches and, includes only one chromo-lithograph pictorial illustration, which is included here. This view of Salt Lake City is based on a photograph by Alfred A. Hart. The rare book room of the Library of Congress has two copies of Hart's book, (call letters F594.H32, copies 1 and 2). The chromo-lithographs contained in copy 1 have the following titles. (The Hart CPRR stereograph number from which the chromo-lithograph is loosely copied is shown in brackets, where one exists):

Donner Lake and Railroad around Western Summit-Sierra Nevada Mountains.[No. 127]

Yosemite Falls, Yosemite Valley-Sierra Nevada Mountains.

The Palisades, Humboldt River-Nevada. [No. 338 without the people]

State Line, Truckee River, Sierra Nevada Mountains. [No. 267]

Devil's Gate, Weber River, Wahsatch [sic] Mountains.

Giant's Gap American River-Sierra Nevada Mountains. [76]

Big Trees of Calaveras-Sierra Nevada Mountains.

Residence of Brigham Young, Salt Lake City, Utah.

Bridal Veil Fall, Yosemite Valley-Sierra Nevada Mountains.

Donner Lake from the Railroad. [No. 258(a)]

Pulpit Rock, entrance to Echo Canyon.

The Devil's Slide, Weber Canyon-Wahsatch [sic] Mountains.

All of these illustrations bear the notation that they were *photographed* by Alfred A. Hart. In the instances where a Hart original is available, it is evident the lithographer, Charles Schober, exercised a considerable degree of artistic freedom in preparing the chromo-lithograph.

2. Hart's *The Traveler's Own Book* was probably finished in the early part of 1870 because the distance table is based on San Francisco. Distance along the railroad was measured from Sacramento during 1864 to late 1869.

3. Hart's clever time chart on page 217 illustrates a problem which became apparent in the United States with the advent of railroading and with the completion of the transcontinental telegraph. The complexities of timekeeping can be seen in an article appearing in the La Porte (California) *Mountain Messenger* (March 1, 1862 page 2, col. 3):

DIFFERENCE IN TIME.--When it is 12 o'clock M at, San Francisco, it is 14 minutes past 3, at New York, 25 minutes 48 seconds past 3 at Boston, 19 minutes 44

seconds past 2 at Chicago, 50 minutes and 40 seconds past 2 at Charleston, 9 minutes and 40 seconds past 2 at New Orleans, 9 minutes and 4 seconds past 2 at St. Louis and 41 minutes and 40 seconds past 1 at Salt Lake..."

In a letter dated May 10, 1869, which appeared on the front page of the *Sacramento Daily Bee,* Reporter George Parker said: "The trains on the Central Pacific run only on Sacramento time, which is telegraphed to the various stations from solar observations made by the time keeper." The small stations along the CPRR probably kept railroad time, but the traveler needed Hart's time chart when leaving the train in a larger city. (See also pp. 43-44.)

4.In the samples of the text describing the journey in Hart's book pp. 4-5, the direction of the trip is westward although the pagination of Hart's map is to the east. This is not the problem it might appear, because the map consisted of panels folded with accordion pleats to fit the book. The San Francisco end was bound into the gutter, but by opening the outermost fold, the trip could also begin at the Chicago end.

5. The CPRR had planned that the western terminus of the track should be at Yerba Buena (Goat) Island in San Francisco bay. On page 7, Hart's map shows that extension, although it was never built, and the project cancelled by an act of Congress in 1873.

6. Although in his book, Hart's map extends on from the CPRR over the UPRR and connecting railroads to Chicago, only the CPRR portion of the map (San Francisco to Ogden) has been reproduced in Appendix G.

7. The distances from San Francisco in Hart's book can be reconciled with those in Appendixes A, B, and C for distances from Sacramento by adding 138 miles to the Sacramento miles, since in 1870 it was 138 miles by rail from Sacramento to San Francisco around the bottom of San Francisco Bay.

PAGES 213 THROUGH 232 KEY LINES-DONT PRINT- FOR POSITION ONLY. iN REPRODUCING REVERSE BLACKS & WHITES SO BACKGROUND IS WHITE AND HART'S BLACK BORDERLINES PRINT.

Reading List and Selected Bibliography

This list includes the readily available material used in preparing this volume and a few periodicals which a reader might find interesting. Rare books and manuscripts only available in libraries like The Bancroft Library, the California State Library, The Huntington Library, or the Library of Congress are not listed.

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Albright, George L., *Oficial Explorations for Pacific Railroads*. Berkeley, California: University of California Press, 1921.

Benton, Thomas H., *Thirty Years' View*. New York: D. Appleton, 1856. Senator Benton was an active proponent of the Pacific Railway even during the years covered by this book, 1820 to 1850.

Bowles, Samuel, *Across the Continent: A Summer's Journey to the Rocky Mountains...and the Pacific States with Speaker Colfax*. New York: Hurd & Houghton, 1866. Contains extensive reports on visits to various dignitaries in San Francisco and conver- sations with Leland Stanford. Schuyler Colfax visited Illinois-town, California, on the CPRR with Stanford, and the nearby rail terminal was named "Colfax."

Central Pacific Railroad, *The Railroad Laws of California and the By- Laws of the Central Pacific Railroad Company*. Sacramento: H. S. Crocker & Co., 1862.

Clark, George T., *Leland Stanford, War Governor of California,Railroad Builder and Founder of Stanford University*. Palo Alto, California: Stanford University Press, 1931.

Crain, Jim, *California in Depth*. San Francisco: Chronicle Books, 1994. An attractive and excellent source of information on stereographs of California, Hart's railroad views, and free viewing (at which Mr. Crain is a master). A folding stereoscope is included.

Davis, Jefferson, Secretary of War, *Reports of Explorations and Surveys, to Ascertain...the Route for a Railroad from the Mississippi River to the Pacific Ocean*. (12 volumes in 13). Washington, D.C.: various printers, 1855-1860.

Deverell, William, *Railroad Crossing, Californians and the Railroad, 1850-1910*, London & Berkeley:University of California Press, 1994. The author gives an excellent account of the resistance to various railroad policies particularly after Hart's CPRR days. The battle lines which the author carefully delineates were actually forming during construction of the transcontinental route.

Drinker, Henry S., *Tunneling, Explosive Compounds, and Rock Drills with a History of Tunneling from the Reign of Ramses II. to the Present Time*. New York: John Wiley & Sons, 1878. This volume of 1,031 pages plus appendixes and folding charts, has on the title page a tiny miner's hat equipped witha candle and below, the Latin inscription, "in tenebris lux" (In a dark place, light). The book contains over 1,000 illustrations and fully meets the expectations promised by the title and the inscription.

Forney, M. N., *Locomotives and Locomotive Building*. New York: Wm.S. Gottsberger, 1886. Reprinted in 1963 (1250 copies) by Howell-North Books, Berkeley, California with a forward by Grahame Hardy. In addition to a good history of locomotive use in America from Horatio Allen's first run of a locomotive here on August 9, 1829 to 1886, this volume was also a catalog of the Rogers Locomotive Works of Patterson, New Jersey. As an example of the detailed illustrations, there are 29 line-drawings cross sections of smokestacks 1836-1886 for wood, anthracite, and bituminous coal. The author mentions on page 27 that at first steam pressure gauges were not used on locomotives, but their advantages later became apparent.

Griswold, Wesley S., *A Work of Giants.* New York: McGraw-Hill, 1962. A wonderful source of detailed and accurate information on the Pacific Railroad and the nine-page bibliography contains about 225 entries.

Hinckley, Helen, *Rails from the West, A Biography of Theodore D. Judah* San Marino, California: Golden West Books, 1969. This book contains a very sympathetic history of Judah's part in the early years of the CPRR, and includes 19 Hart CPRR views without credit to him. Some details on building the CPRR are incorrect, but not really pertinent to Judah's work.

Holliday, J. S., *The World Rushed In.* New York: Simon & Shuster, 8th printing 1995. A classic, covering the period in California 12 to 14 years before the start of the CPRR, and the people who rapidly built the state into almost a small nation.

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National Stereoscopic Association, *Stereo World.* Columbus, Ohio published bi-monthly by the association. It contains articles and many illustrations by members on all sorts of stereographic information from antique to electronic. Information may beobtained by sending a stamped, self-addressed envelope to: The National Stereoscopic Association, P. O. Box 14801, Columbus, Ohio 43214.

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Palmquist, Peter E., *Carleton E. Watkins, Photographer of the American West.* Albuquerque: University of New Mexico Press, 1983. Beautifully illustrated with large Watkins prints and contains extensive information on Watkins' life and photographic methods.

Root, Marcus Aurelius, *The Camera and the Pencil...being at once a Theoretical and Practical Treatise.* Philadelphia: J. B. Lippencott & Co., 1864. Reprinted in 1971 by Helios of Pawlett, Vermont with a forward by Beaumont Newhall. This classic gives an excellent account of the state of the art of photography at the time Hart was taking photographs. It also contains extensive information on the technical and historical aspects of photography up to 1864.

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