WHAT IS A DREDGE?

DREDGING THE CREEKS

Gold mining takes place in either of two generally characterized types of operation, lode and placer mining. Lode mining, often referred to as "hard rock mining," involves following a mineralized vein or an ore body by means of drifts, shafts and tunnels into the deep recesses of the earth. Placer mining, on the other hand, takes place on the surface. Placer deposits result from mineralized areas (veins, ore bodies, etc.) having been eroded and transported by water or other natural action from their original location to areas conducive to concentrating the minerals. In the case of gold, water action transports the gold to areas where the heavier particles settle and accumulate in natural riffles, cracks and holes. Getting at the gold involves a process of separating it from the surrounding sand and gravel, and disposing of the waste material, called tailings. Separating the gold is easily accomplished using a gold pan, a sluice box (designed to imitate the natural processes of a stream), or a rocker, essentially a "sluice-on-a-cradle." [1]

There is a direct correlation between the amount of gravel a miner can process to the amount of gold recovered and thus the profit derived from the placer deposit. The more gravel that is processed, the more gold and higher the potential profit. It is said often, a single miner, working a claim by hand could process approximately one cubic yard (twenty-seven cubic feet) of material each day. By using a sluice box, rocker, or other similar small-scale mechanical equipment, the quantity increases accordingly. To move substantial amounts of gravel it takes something capable of taking huge bites, repeatedly, day in and day out, especially given the short working season in Alaska. Dredges fit that bill.

Measured in terms of the quantity each bucket holds, dredges used in Alaska range from small one and a half cubic feet to upwards of fourteen cubic feet. Many of those working the gold fields in the Klondike had buckets capable of digging sixteen cubic feet, and more. Even a small one and a half cubic foot dredge with fifty buckets was capable of digging almost three times the amount that the solitary miner could, with each rotation of the bucket chain! Moving five hundred yards of gravel a day was not out of the question with a small dredge.

In order for dredges to be effective, a great deal of money had to be spent up front with prospecting and testing the ground to determine the location, size, and basic orientation of the gold. Often extensive drilling programs were undertaken to determine where the greatest concentrations of gold accumulated. Depending on their configuration (length of the digging ladder and number of buckets) dredges could be used to great depths. However, they were often not effective if the gold was less than two feet deep due to the angle of the digging ladder in relation to the face of the cut. In other words, the gravel would not stay in the buckets long enough to rise to the hopper leading to the screen.

Often when faced with a dredge of limited digging depth, an operator lowered the water level in the dredge pond, thus lowering the dredge. This practice had the potential to create its own problems. By lowering the water level, the digging face was raised an equal distance. This in turn created situations where the digging ladder would undercut the bank causing dirt, gravel and rocks to fall into the pond. At times, the ground would cave and build up under the lower tumbler. This in turn could cause the bucket line to ride off the tumbler; similar to the way a bicycle chain can ride off its sprockets. [2] One solution, if the higher ground was barren of gold, was for the operator to shut off the water to the screen running it dry. This allowed the bulk of the material to pass through the dredge onto the stacker and out onto the tailings beyond. It was far better to have it behind the dredge crowding it forward than under the ladder. [3]

The largest Alaskan dredges were on the Seward Peninsula and around Fairbanks. Smaller dredges such as those at Coal Creek and Woodchopper Creek were capable of handling between three and five cubic feet in each bucket. [4] Dredges mark the apex of placer operations in Alaska mining history. [5]

Early attempts at dredging appeared on the Alaska scene during the Nome rush at the turn of the century. All manner of "jackass machinery" were developed for working the beaches and benches around Nome. [6] Many of these contraptions were destined to die as wrecks living only in humorous tales. Fortunately, photographs survive illustrating the variety and ingenuity of mining equipment that would have made even Rube Goldberg smile. [7]

Gold dredges are an impressive piece of mining equipment. Contemporary descriptions range from looking "rather like a river steamer with a penthouse on top," to a description of one as a "large scow with heavy machinery and housing on it, and closes up behind as it edges slowly along a creek bottom — like some prehistoric monster reaching out its long neck of chain-and-buckets, rooting in the earth with its metal snout, and drawing in enormous daily meals of golden gravels." [8] They continue to conjure up images of prehistoric creatures lying solitary, abandoned and rusting on the tundra or in creek beds surrounded by the evidence of an insatiable appetite for gold.

Descriptors of dredges are colorful in their own right. Often called "ugly, spectacular, and awesome, these machines might cost half a million dollars apiece rivaling ocean going freighters in size. Tirelessly they clanked relentlessly along, floating in their own dirty pools, tearing pay dirt from bedrock twenty or even a hundred feet below the surface. From these 'metal mastodons' came a 'tremendous air-shaking medley of sounds' — 'the crunching, groaning, roaring, grinding, clattering of stones' falling on metal screens and then onto gold saving tables. Around the clock they worked, their main concern the cubic yards of gravel dug and dollars of values extracted." [9]

Even with the corollaries drawn with monstrous animals gobbling up huge amounts of real estate, there was something romantic about the gold dredge. Terms like the "Modern Gold Ship" and "Flagships of the Gold Fleet" caught the public imagination. Popular writers saw the dredge as "the combined perfection of all the primitive ideas and methods and the realization of the dreams of the early miners." The dredge was a marvelous invention. Able to do the work of an army of men and to make a profit where none existed before. It "could mull through as much gravel in a day as a thousand prospectors with their primitive methods, and wind up the day without a backache." Because of this new miracle, a distinguished monetary expert noted in 1903, the world would "not only be saturated with gold, but it would be nauseated with it." [10]

Unlike miners working their individual claims, dredges operated continuously, seven days a week, for the entire season. In actuality, this averaged roughly 23 hours a day. Crews used the additional hour for oiling and greasing the parts that "could only be reached when the dredge is idle" and for moving the dredge forward in the dredge pond. [11]

WHAT IS A DREDGE?

A dredge combines the four basic principles of mining: digging, classifying materials, gold saving, and disposing of waste materials or tailings. A generic description explains it as:

. . . a combined excavating and concentrating plant [looking] like an animated houseboat. An endless chain of mammoth steel buckets — a hundred or more, each weighing more than a ton — digs the gravel and delivers it to the upper end of a revolving screen through which the gold laden gravel passes to tables or riffles. The oversize gravel is discharged onto an inclined belt-conveyor called the*stacker,* which carries it to the tailings pile. [12]

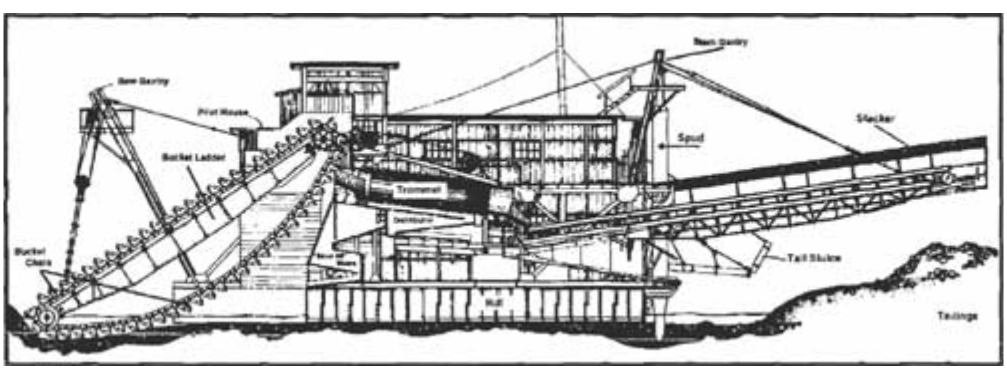

Figure 1: Coal Creek Dredge (Historic American Engineering Record (HAER) Drawing — National Park Service)

Dredges fall into four basic types: (1) flume; (2) screen and flume; (3) combination; and (4) stacker. Each works by means of an endless chain of buckets, linked one behind the other, rotating around a digging ladder that is capable of being raised and lowered as necessary. [13] The modern equivalent in principle although not in use, and on a much, much smaller scale, is the trenching machine known as a *Ditch Witch©.* In both cases a series of buckets (or shovels) move in an endless chain around a solid arm, constantly bringing more and more material up the chain as it moves forward into new ground.

FLUME/SLUICE DREDGE

On a flume dredge, the buckets dump directly onto the head of a long sluice running down the axis of the boat. Essentially providing a mechanical means to bring large quantities of gravels from in front of the dredge and run it through a sluice. It dumps far enough astern to avoid interfering with its operation and to keep the dredge afloat. Flume dredges are only useful in shallow ground with material that is both small in size and easily washed. Their biggest benefit came in working narrow, rich, wet paystreaks.

In most cases, flume dredges were small, with buckets ranging from one and a half to three cubic foot. According to Charles Herbert, this type of dredge was capable of processing no more than 500 cubic yards of material daily. Their small size often meant low cost, which allowed operators to get into the dredging business with less capital than that required for larger operations. [14]

SCREEN [15] AND FLUME DREDGE

With a screen and flume dredge, the buckets deliver the gravel into the head of a revolving screen that separates the larger gravel from the smaller material and sends it off the stern by means of a chute. In some cases, rather than using a revolving, tumbler-type of a screen, dredges used a flat, table-like screen (called a "shaker" or "shaker deck"). The purpose here was to break up the larger pieces of dirt and classify materials allowing the finer particles to pass through the sluice for gravity concentration. Advantages of this type of dredge include: the ability to work ground with larger gravels and boulders; and the revolving screen to help wash the gravels, separating the sticky mud, etc. from it before sending it down the sluices. The chief disadvantages of the screen flume dredge are that it is limited to only digging shallow ground. According to Charles Janin, "it is difficult to keep the flume open in cold weather without the mechanism being enclosed as is the case on the table stacker dredges." [16]

From here, he went on to work for the Fairbanks Exploration (FE) Company, and eventually owned several of his own dredges in the Fortymile country. (Chuck Herbert, interview in Anchorage, Alaska, July 28, 1998).

There were several dredges of this type working in Alaska in the early 1930s. One, on Cache Creek in the Yentna district, had six and a half-foot buckets and operated by hydroelectric power.

COMBINATION DREDGE

The third type of dredge, the combination dredge, combines the revolving screen with a mechanical stacker (basically a conveyor belt) to remove the coarse material well astern of the boat. The smaller gold bearing gravels pass through the screen, fall onto a wide riffled sluice that discharges onto additional sluices connecting to two long flumes on either side of the hull.

Although this dredge design is both light and inexpensive, it was recommended for use only in shallow ground and because of the nature of the sluices. It had the same inherent problems of both the sluice dredge, and the screen and sluice dredge. It could only operate during mild weather to prevent the flumes from icing over. According to Herbert, there were few of this type of dredge in Alaska because of the short seasons. [17]

TABLE STACKER DREDGE

The table stacker type of dredge is the most familiar to people living around or visiting the gold fields. By far the majority of the large dredges built for Alaskan operations represent this type.

In this case, the bucket line delivers the material to a hopper at the head of a revolving screen. As it passes through the screen, the smaller materials fall through a series of holes — smaller holes are located toward the head and larger toward the tail of the screen. The material too large to fall through moves off the stern by means of a mechanical stacker/conveyor as in the combination dredge. The material that continues through the dredge falls onto one or more banks of riffled sluices called tables. From there, it passes down each side into additional sluices. Then the fine material (gravel and sand) washes off the stern by means of short tailings chutes. In the case of this type of dredge, the flumes do not freeze up as readily as the others do. The stacker removes the bulk of the waste material. The flumes are shorter and housed almost entirely within the dredge housing itself.

BUCKET CHAIN

Like much of the mining industry in general, technological advances were few until very late in the twentieth century. Most advances in dredging came principally in the use of alloy metals, incorporating electrical equipment into their operation, and advances in the design of the bucket line. The basics remained constant throughout the dredge era.

Material was scooped out of the ground, processed through the screen and sluices, then removed and dropped behind the dredge with the finer gravels processed through a system of sluices to recover the gold.

Several overlying principles govern dredging in Alaska. First, economics. Manufacturers in the Lower 48, constructed the new dredges, shipped them to Alaska in pieces then assembled them on-site. Shipping costs often accounted for two-thirds of the final cost of the dredge. Replacement parts likewise were expensive to ship north.

Second, was the nature of the ground being dug. In loose ground, dredges used a large bucket. If there was a possibility of encountering hard packed, frozen or ground consisting primarily of boulders and other large gravels, a smaller bucket was more efficient. The economics of scale enter the picture of dredging again. A larger bucket was by its nature capable of putting larger quantities of material through the process, but if a large bucket were coming up only partly full because of ground conditions, a smaller dredge would actually be more economical.

According to Herbert, "very small buckets were favored for most Alaskan dredges but this is probably caused by lack of capital." Several dredges on the Seward Peninsula used nine-foot buckets quite satisfactorily. The Fairbanks Exploration Company (F.E. Company) had two - ten foot dredges and three - six foot dredges in its fleet and which set new records in Alaskan dredging. By contrast, in the Yukon Territory there were a number of dredges operating each with buckets capable of handling fifteen or more cubic feet. Without going into too much detail, Herbert theorizes that it is "doubtful if [the Canadians'] yardage records are much better than those of the ten-foot dredges at Fairbanks." [18]

Bucket chains are described as either open- or close-connected. In an open bucket chain, a link is placed between each bucket. Because of its nature (see Figures 7 and 8 below), a close-connected bucket chain has twice as many buckets. The advantage of open chains is that in the event a large boulder is lifted by the chain, there is less likelihood that it will catch between two buckets breaking either one or the pin between buckets, and thus the chain itself. This in turn meant shutting down the dredge while making repairs. Again, keeping the dredge running, at full capacity, meant more material was processed and more gold recovered. On the other hand, a close-connected chain meant allowed processing twice the amount of gravel through the dredge each day.

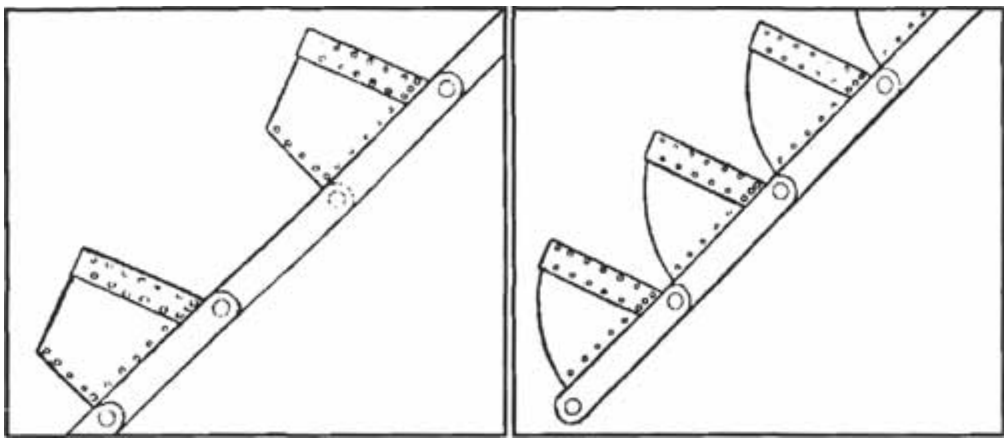

Figure 2: Open-Connected Buckets (left); Figure 3: Close-Connected Buckets (right)

Buckets themselves consist of two parts, the bucket — cast of solid manganese steel and the cutting edge, called the "lip" which is often a separate piece either riveted or welded to the bucket. The nature of the ground determines the height of the bucket lip. A dredge uses a low lip when working a "high" bank, where the material extended well above the level of the dredge pond. This prevented the bucket from cutting more than it could carry ("biting off more than it could chew") when the digging ladder was almost horizontal. Material that fell over the bucket would be lost to the bottom of the pond. When working a "low" bank, or if the bank caves easily, dredges switch to a higher lip to keep the material in the bucket. Like the buckets themselves, the lips were made of manganese steel. Where ground was easy to dig, they tended to last a long time. However, when encountering frozen ground, the lips wore out rapidly. The U.S. Smelting Refining and Mining Company (US SR&MC) at Fairbanks reported normally getting a single season out of a set of lips. [19] The bucket lips on the dredges at Coal Creek and Woodchopper Creeks tended to last only slightly longer than on those dredges working around Fairbanks. In the cases of these two dredges, the company replaced the bucket lips after approximately 200 days of digging, or every other season. [20] By 1947, both companies were re-placing the bucket lips as part of their annual maintenance at the beginning of each season. [21]

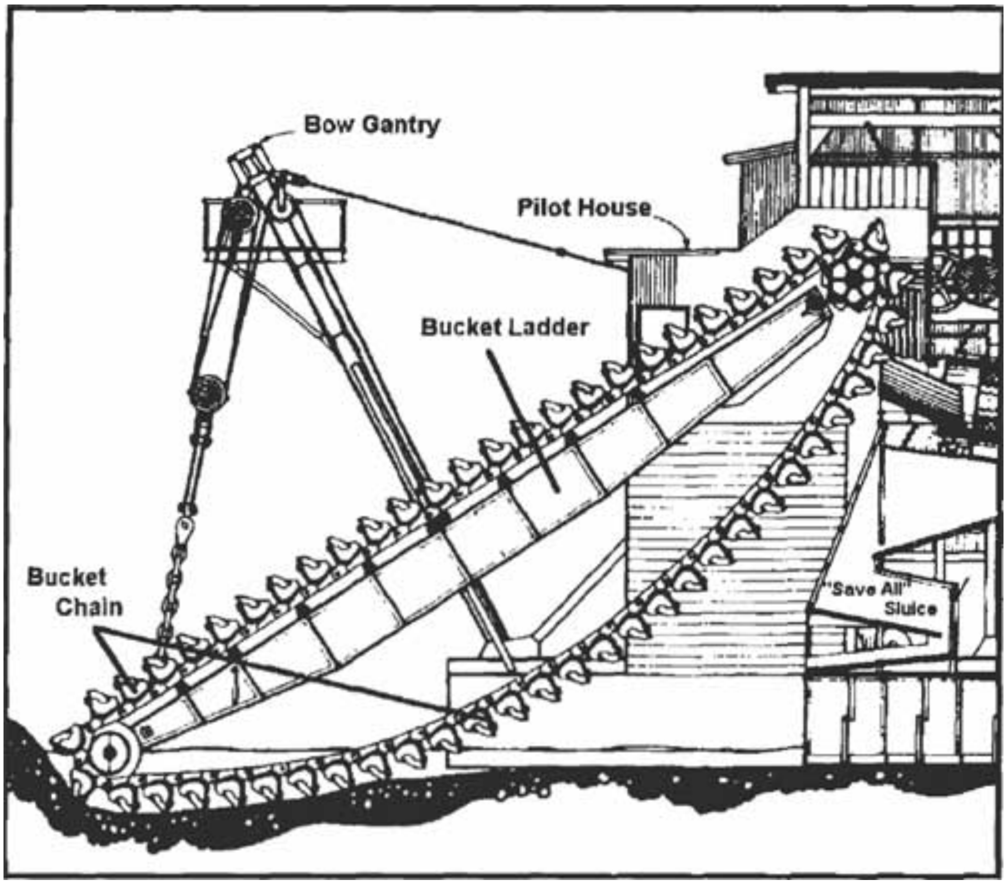

Figure 4: Coal Creek Dredge, Bow and Digging Ladder

Using replaceable lips extended the life of a bucket somewhat. The F.E. Company found that most of their buckets lasted only about four seasons, roughly 1000 dredging days. Although the bucket lips wore out because of the constant grinding and digging action, the areas most prone to failure were the eyes where the pins connect the buckets. In some cases, patches could be welded in place, but experience proved that by the time patches were used, the bucket was generally in poor condition overall and required replacement soon after. [22]

The ground at Coal and Woodchopper Creeks consisted mainly of well-thawed gravels ranging from small to less than a foot in diameter. Specifications for these dredges call for replaceable, moderate sized lips, nine inches wide with a cutting edge one and one-quarter inches thick. Rivets attach the lips to the buckets. [23]

During the 1930s and 40s at Coal Creek and Woodchopper, the dredge buckets differed slightly from those used on other dredges throughout Alaska and the Yukon. In the case of Gold Placers Inc. and Alluvial Golds Inc., the lips on their buckets not only extended up from the top of the bucket but also comprised approximately one-third of the bucket sides as well. Each spring new lips were riveted onto the bucket chain and the old ones thrown away. As financial conditions worsened following World War II, the companies attempted to weld material onto the old lips thereby extending their life as far as possible. About the same time, one manufacturer developed a new design using a lip that fit into a groove on the bucket securing it with two bolts. This idea worked for several years as the new design consisted of less metal and was easier to put on and take off. Eventually the company realized that much of the lip was still wasted and thrown away when replacing them. [24]

The dredges at Coal Creek and Woodchopper fell into the same maintenance schedule for replacing bucket lips, approximately once per season depending on the condition and type of bedrock they worked the preceding year. In 1950 or '51, the company contracted with the AMSCO Foundry in Portland, Oregon to manufacture fillets that were welded to the bucket lips. These increased the capacity of each bucket from four feet to roughly four and a half cubic feet. Each season, welding the new fillets onto the old lips and repairing pins, rollers and bucket eyes kept one welder occupied for almost the entire summer. This also aided in lowering the maintenance costs associated with re-lipping every season. [25] By this time in the history of the companies, saving any little bit on maintenance and replacement parts meant quite literally the difference between operating for another season or not.

The pins connecting the buckets had to withstand tremendous stresses and strains. Commonly made of nickel-chrome steel, the dredge at Coal Creek has pins measuring three and one-half inches in diameter. [26] The company attempted to make pins last longer, including welding additional metal to them and machining them to size. Originally, this proved less than optimal. Later, the introduction of new alloys allowed the machine shop at Coal Creek to weld successfully the bucket pins.

Successful dredge companies, like Gold Placers Inc. and Alluvial Golds Inc., had a substantial investment in spare parts for making necessary repairs. Downtime, waiting for new parts shipments from the Lower 48 or for the machine shop to repair broken parts meant a decline in an already meager profit margin. When it came to buckets and bucket pins, the Coal Creek and Woodchopper dredges had a supply that covered both dredges (one chain each) with a spare bucket to feed into the line if needed. As buckets wore, welding patches to the bottoms and sides extended their life as much as possible. In the case of buckets, an operator only purchased what was absolutely necessary. [27]

DIGGING LADDER

The bucket chain moves in a continuous chain around a "plate girder-type" arm called the digging ladder, in much the same manner as a bicycle chain. In the case of the Coal Creek boat, the ladder is made from steel plates ranging from one-quarter to one-half inch thick and bolted together. The key to the strength of the digging ladder lies in its interior bracing. [28] The gravels at Coal Creek required a ladder capable of digging to a depth of 14 feet when digging at a 45° angle. Because there was a possibility that the gravels may go deeper in places, the Walter W. Johnson company made provisions to enable extending the ladder to dig to a depth of twenty feet. The bucket chain rides along the top of the ladder on a series of nine-inch diameter steel roller bearings. To support the tremendous weight of the loaded buckets, the rollers turn on shafts nearly three inches in diameter. The lower end has a soft cast iron bearing while cast steel hanger bearings support the upper end. The upper bearing had to be considerably stronger because it was supporting the entire weight of the digging ladder in addition to that of the loaded bucket chain. [29]

SCREEN

As the buckets cycle over the digging ladder, they empty into a hopper [30] at the head of a large, revolving screen (similar to a clothes washing machine tub), sometimes called a "trommel." A series of perforated plates made of high carbon or manganese steel make up the trommel. An early variation on the screen consisted of a shaking table, but since the purpose behind the screen is to break up as many lumps of material as possible, the revolving screen proved more suitable. High-pressure nozzles placed at the head of the screen and along its axis spray water onto the material passing through. This water also assists in moving the smaller material over the gold saving sluices.

In observing a working dredge, or modern sluicing equipment, one would be surprised at the quantity of water and the force spraying onto the alluvial material passing through the screen. The water jets are placed far enough back inside the screen so they do not blow the dirt back up into the hopper and thus prevent it from passing through the screen. Dale Patty commented that, "as a kid I always felt there was too much water and the gold would go out the back end." [31] Conversely if there is not enough water, the gold will not separate from the waste material and go out the stacker onto the tailings. As it turns out, moving too much water through the dredge only affects the water quality not recovery. On the other hand, moving the water through the dredge too fast does have a negative affect on gold recovery. [32]

On many dredges, the holes in the screen increase in diameter toward the stern generally from 3/8 of an inch to 1-1/2 inches in the lower sections. In some cases, a grizzly [33] is placed at the lower end of the screen. This permits the smaller material that may have passed through the screen to fall into a small "nugget sluice." This catches any nuggets too large to go through the holes in the screen. [34]

Because of the physical nature of the gold at Coal Creek and Woodchopper -- the gold consisted of small, fine nuggets that readily passed through the holes in the screen, during most years the nugget sluice was not needed. Except during the 1954 season when the Coal Creek dredge worked an area unusually rich in nuggets larger than the holes. At the Board of Directors meeting that year, Dale Patty, mine manager and vice president of the companies, took a cigar box full of large nuggets to the meeting intending to give them to the directors as a "gift" from the mine. Much to his surprise, Ernest B. Bull, [35] the chairman of the board recommended, and the board unanimously concurred, to give the box of nuggets to Dale as a thank you bonus for the good work he did running and overseeing the operations. [36]

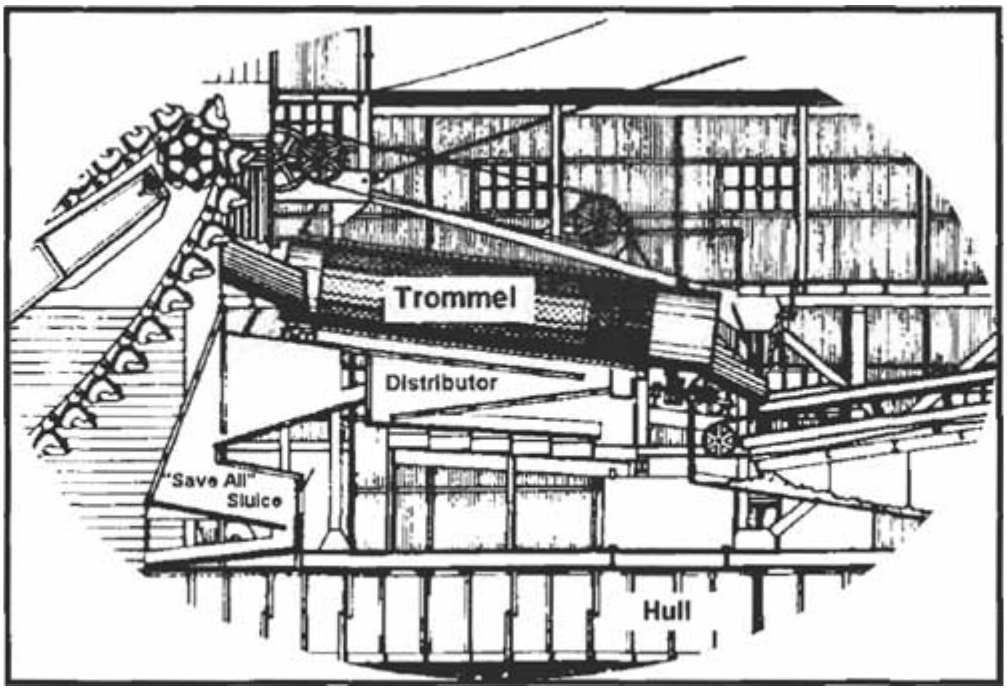

Figure 5: Coal Creek Dredge, Screen, "Save All" Sluice and Distributor

The screens on the Coal Creek and Woodchopper Creek dredges are 60 inches in diameter (5 feet) and 20 feet long. Shell plates and bearing surfaces on each end add an additional 6-1/2 feet overall. There are five sets of plates, each four-feet long that make up the barrel-like screen. The screen perforations are uniform in the upper 4 sections. Measuring 3/8 of an inch diameter on the inside, tapering outward to 1/2 inch on the outer surface to prevent gravel and other material from jamming in the holes. All of the holes in the screens are spaced uniformly making each panel interchangeable. [37]

SLUICES

As the alluvial gravels traveled down the screen, the smaller particles of sand, dirt, and of course gold, would fall through the holes in the screen and land on the sluices below. On dredges like those at Coal Creek and Woodchopper, there are a number of different sluices, each serving a different purpose, and each accounting for a different percentage of the gold captured.

The *upper screen sluice* is located directly below the screen and at the same angle (from bow to stern) as the screen. This accounted for approximately 70% of the recovered gold. The*lower screen sluice* runs toward the bow with a slope opposite to that of the screen. It captured approximately 20-22% of the gold. These two sluices were the only ones to which mercury was added to form an amalgam with the free gold. [38]

Figure 7: Riffles showing the wear occurring on the corner of the angle iron from the constant pounding of gravel and sand. The water flows in the direction indicated. NPS photo, Douglas Beckstead, July 2001.

Figure 8: Nugget sluice with wooden "Hungarian" riffles in place. The water and material flows from the top left to lower right of this photo. NPS photo, Douglas Beckstead, July 2001.

The dredges that worked Coal Creek and Woodchopper Creek each have six *side sluices*running outboard from below the screen. These averaged between 6-8% of the gold recovery. As noted earlier, the *nugget sluice* was located immediately aft of the screen (at the junction between the screen and stacker) to catch any nuggets that might have been too big to fall through the holes in the screen. This prevented them from going up the stacker belt and being dumped into the tailings. The *nugget sluice* and *save-all* accounted for approximately 2% of the total gold recovered. In the case of the dredges on Coal Creek and Woodchopper Creek, because the nugget sluice accounted for such a small portion of the recovered gold, it was cleaned up only once or twice a year. [39]

Originally the sluices had *riffles* made from 1 X 1-1/2 inch wooden slats with thin sheet rubber nailed to the bottom to protect the top of the riffle from excessive wear due to the abrasive action of the sand and gravel flowing across it. This type of riffle is known as a "Hungarian riffle." [40] Later the company found that a new style of riffle, made from a grate of one-inch angle iron proved more efficient. In placing the new riffles in the sluice, the angle stands on one edge with one side vertical and the upper side horizontal, similar to the gallows in the child's game "Hangman." The water flows from the solid side over the riffle toward the open side where the natural hydraulics create an area of low pressure behind the angle giving the gold a chance to settle out. [41]

"SAVE ALL"

Although dredges were primarily collecting the coarse gold from placer deposits, crews made every effort to catch even the smallest amount of gold that might slip past the machinery. A device called the "Save All" sits below the upper end of the screen, below the upper bearing of the digging ladder. Its purpose is to catch the mud and small material that was still clinging to the buckets after they had emptied into the hopper. The collecting pan and grizzly extended as far forward as the sag in the bucket chain would allow. Because the digging ladder moved up and down, thus varying the angle and the sag in the bucket chain, the save all is adjustable by means of a series of holes and pins. [42]

STACKER

Waste material (gravel, etc.) passed down the the screen, and over the nugget sluice where it drops onto the stacker. The stacker is a conveyor belt suspended below the screen chute and from the stern gantry. It is used to deposit the tailings well astern (behind) the dredge. The side-to-side action of the dredge as it digs is duplicated at the end of the stacker. As a result, the tailings are deposited in a crescent shape. It is easy to tell the direction the dredge was moving by examining the points of the crescents which point in the direction of travel.

In order to keep the stacker belt from freezing, steam pipes from a boiler on board the dredge often ran its length. Tailings moved along the stacker on the Coal Creek and Woodchopper Creek dredges on a thirty-inch wide conveyor belt riding over idler rings spaced every four feet. Corrugated steel roofing, extending four inches over each side with canvas sidewalls protect the stacker and tailings from cold weather. This allow a stacker dredge to work longer seasons than flume-type dredges. [43]

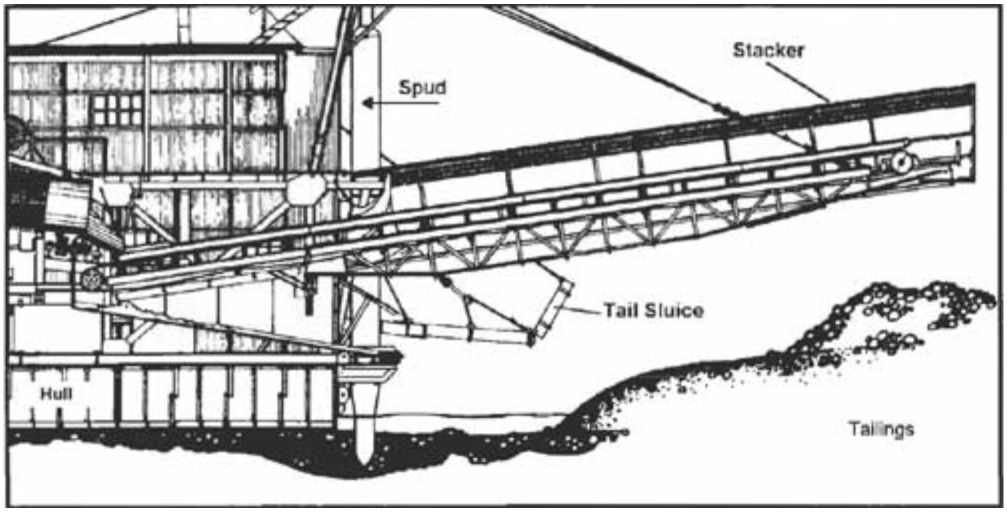

Figure 9: Coal Creek Dredge, Stern with Stacker and Spud

SPUD

Depending on the size of the dredge, and its manufacturer, there would be one or two spuds at the stern of the boat. These serve to brace the dredge against the digging face and as pivot points for moving the digging ladder laterally across the face. On some smaller dredges, the spud was made of wood. However, since the spud is susceptible to severe strain both by bending as a simple beam (like a nail or spike being pushed from the side) and in torsion (twisting) as the bow moves side to side, most were built up from heavy steel plates. Experience proved that it was better to bolt the plates together than to rivet them. Bolts allowed them to flex, distributing the stresses rather than concentrating it on few fixed points. Rivets tended to work lose or break. If bolts worked loose, they were easily tightened.

The bearing plate at the stern required careful design and sufficient mass to distribute the pressures exerted between the spud and hull to avoid potentially catastrophic failure on the part of the hull. In the 1930s, most Alaskan dredges had the spud bearing against a large casting, several feet wide spanning the width of the stern and extending the depth of the hull. [44] As an example, the spud for the Canadian Dredge No. 2 on Bear Creek outside of Dawson was 65 feet long and weighed 27 tons. [45] In contrast, the spuds on the Coal Creek and Woodchopper Creek dredges are 40 feet long. These spuds were fitted with "heavy cast steel points at [their] lower end." [46] Extrapolating the size between th dredges yields an estimate that the Coal Creek and Woodchopper spuds weigh nearly 1 tons each. This accounts for nearly five percent of the total weight of the dredges.

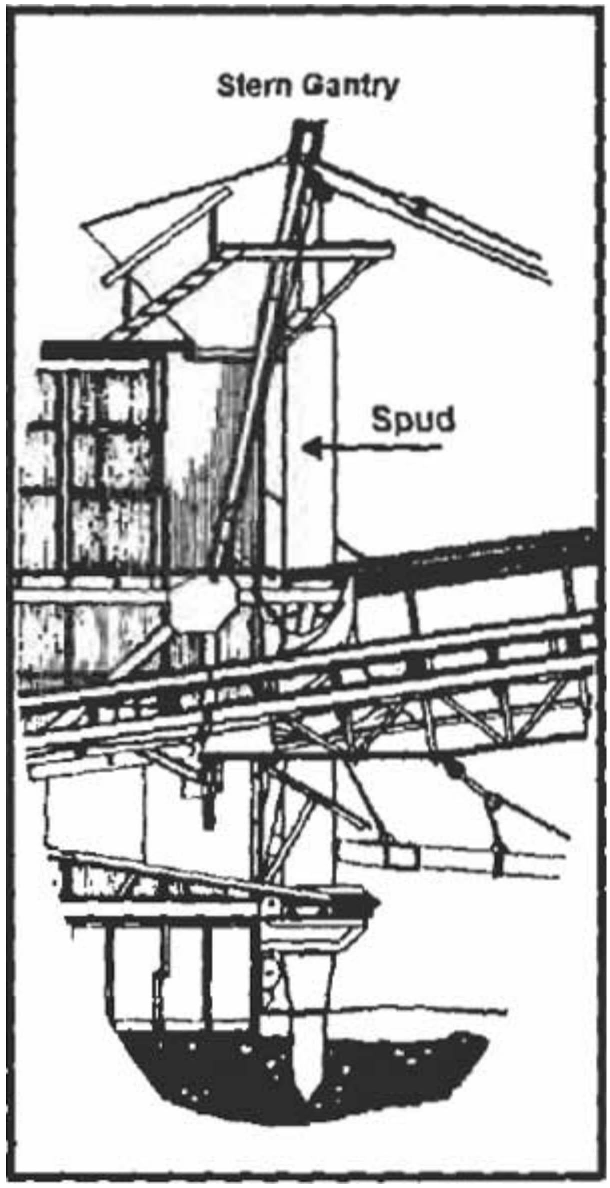

Figure 10: Coal Creek Dredge Spud

To move the dredge forward, the winchman raises the spud by means of the rear gantry and spud winch. The boat is then pulled forward by the bow lines after which the spud was dropped, driving itself by shear weight and momentum into the bedrock below. The tip of the spud is shaped much like the snout of a dolphin, long and tapered with a rounded tip. The purpose behind this was to allow the spud to drive itself into the bedrock behind the dredge, yet to pivot in its own hole. If sharply pointed, it would act more like a nail or spike and "stick" in the hole. [47]

Some of the larger Canadian dredges used the two spuds as what they called "stepping spuds." One would be raised clear of the bottom of the dredge pond and the dredge would rotate about it as it went through its normal side-to-side operations. Finally, after it had completed the cut across the face, the other spud would be at the front of the arc (closer to the face) where it was dropped and the trailing spud raised so the process could be completed. This however did not always work as planned. In one case, one of the two spuds sheared off. From that point forth, instead of replacing the spud the company proceeded to operate it as a single spud dredge. [48]

WINCHES

An integral part of operating a dredge is its system of winches and cables. The dredge is essentially a barge on which rests the entire heavy machinery and equipment necessary to carry out its mission of separating gold from alluvial gravel. Systems of winches are used on either side of the bow and stern (a total of four -- port, starboard, fore, and aft). These hold the dredge against the digging face and move it side to side, pivoting on the spud. Winches also raise and lower the spud(s), digging ladder and gangplank.

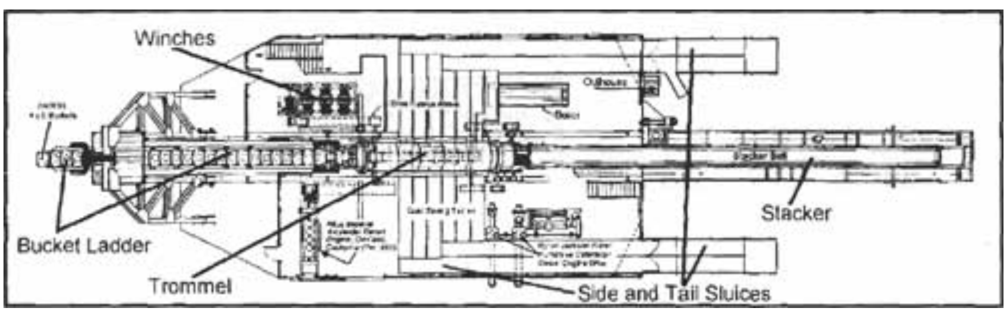

Figure 11: Coal Creek Dredge, Main Deck Layout

The Coal Creek and Woodchopper Creek dredges are set up to handle eight winches. The bow line winches (one on the port side, one on the starboard) swing the dredge port and starboard across the working face. The two stern lines (port and starboard) pull the dredge forward. One winch powers the hoist to raise and lower the digging ladder as the dredge moves side to side across the working face ahead of it. One winch raises the spud. One raises and lowers the gangplank. The eighth serves as a spare if needed. [49] The machinery for the winches is located in the forward portion of the superstructure, on the starboard side. The winchman controls them from the winch room above by a system of levers, linked to gears and clutches. [50]

The winchman (the man operating the dredge) controls the winches from the winchroom. It is located two stories above the main deck at the bow of the boat. From here, he is able to see the bucket line and both sides of the bow. In addition, a small window located at the back of the winchroom, near the ceiling, provides a view of the spud when it is raised and lowered. With the winchman facing the bow, immediately in front of him is a series of levers or controls. On the ceiling above his head, to his left, are two large wooden levers. The one on the left controls the bucket line. Pushing it forward stops the line, pulling it back engages the clutch between the main drive pulley and a small gear that supplies power to the huge bull gear. [51] To the right of the bucket line lever is a second wooden lever that controls power to all of the winches. Like the bucket line lever, pushing it forward disengages the clutch, pulling it back engages it supplying power to the bank of winches. This lever was mainly used to stop the lateral swing of the dredge when the load on the bucket line became too heavy. It was also used when trying to coax a big rock onto the line. [52]

Extending up from the floor of the winchroom is a series of levers that control individual winches. Each has two levers associated with it. One controls the clutch, the other the brake which stops and holds the winch drum in place. Moving port (left) to starboard (right), the first three pairs of levers control the following winches: (1) hoist for raising and lowering the digging ladder, (2) port bow line, (3) starboard bow line. After a small separation between the banks of levers, the remaining levers control the following: (4) port stern line, (5) starboard stern line, control the following: (4) port stern line, (5) starboard stern line, (6) spud, and (7) gangplank. On the far right, two levers do not connect to an active winch. These would serve to control the spare. [53] (NPS photo by Doug Beckstead, June 2001)

Deadmen, heavy objects buried in the ground, anchor the bow and stern lines to the shore. The last time the Coal Creek dredge operated, the company used derelict caterpillar tractors as deadmen. Their mass was sufficient to hold the lines without burying them. Gold Placers Inc. devised a method of burying two deadmen on each side of the pond, with a cable running between them (running cable lines parallel to the direction the dredge was working and moving). The bow and stern lines were then attached to these side cables by means of sheaves (pulleys) locked against the line. When it was necessary to move the bow and stern lines forward, the shoremen removed the lock, pulled the sheave forward with a tractor, then again locked it in place. This eliminated the need to be constantly moving deadmen forward, which in turn saved time, labor and money. [54]