Transporting Materials of Construction by Boat to Western Bank of the Copper River.

THE discovery that veins of high grade anthracite coal and copper deposits existed in western Alaska has caused the completion of a railway to the coast, extending to this section of the territory, at a cost of nearly \$70,000 a mile. But 193 miles in length, the Copper River Railroad represents the solving of one of the most difficult engineering problems in American railway history. It is the most northern line in America, except the White Pass and Yukon, and Michael Henry, its constructor, also constructed the road over White Pass. The building of this railway through a rugged mountainous region bridging a glacial river, crossing a deep canyon—all the work performed in the cold wet climate of glacial Alaska, is a memorial to the energy and ability of the American engineer.

The climate of Alaska in winter is so variable near the coast, that the mercury may be below zero one day while the next day the ice of the glaciers melts, and with the action of the warm Japan current, fragments fall from them and form icebergs, or ice fields. In summer, the edge of glaciers crumble more rapidly, and for many miles the Gulf of Alaska is covered with drifting masses of ice that is forced up the rivers, entering it by the tides, and often choking the estuary completely.

The Copper River is so located that where it enters the Behring Sea, it passes through several outlet channels separated from each other by low banks of sand washed down the stream when in flood. To build the railroad it was necessary to construct a steel bridge 1,150 feet long across the river. The men erecting the bridge had to struggle in ice-cold water filled with cakes of ice rushing down stream in fields, or singly, with such a force that the supports of the bridge had to be massive forms of concrete, set far below the soft bottom upon the rock bed beneath. Above the surface of the water, the piers must rise fully forty feet, in order that floods, often carrying a dense load of floating ice, might not sweep the structure away.

This bridge had to be built across the river where it makes a double turn between the great living glaciers, Miles and Childs. Both present 300-foot cliff-like faces to the water for three miles, and if it were not for the opening between them, the Copper Valley

would be, as was once supposed, utterly impassable for transportation. Where the bridge stands, the current often brings down ice bergs, and hurls them against the bridge piers. In addition, these piers must withstand the breaking up of several feet of sheet ice, under enormous pressure, each spring.

No such problem in bridge building has ever been met before. It was a seeming impossibility that faced the engineer. A million dollars—the cost of the bridge—must be risked on the chance that he and his men could build supports which the ice could not demolish. If they failed in this, the \$15,000,000 railroad to the copper and coal fields would be useless, for the site of the bridge was the only place where the railway could cross.

On account of the floating ice no false work could be used. It would require at least two years to build the railway, and to complete the contract within the time required meant that embankment work and track laying must be under way, on the route surveyed on each side of the river, while the bridge was being erected. To carry men, machinery and supplies across the river a ferry boat was built of wood reinforced with steel plates, but often the waves swept over her, sometimes covering the deck with ice and breaking it down in places; then the ferry boat would be fastened to the bank and repaired, to again resume her perilous trips, carrying pile drivers, stationary engines, rails, spikes, ties and other material for the track layers on the west side, while another gang of men formed the road-bed, laid the ties and spiked down the rails, on the roadway approaching the eastern side of the bridge site. This track was necessary to transport the mass of steel girders, and other forms required for the bridge, as well as rails. It required six months to haul these train loads of material from the mill, across the continent to this far-away land of the glacier.

With the eastern section of the railroad completed, a battle between man and nature began—the building of the bridge. It must be completed within six weeks to comply with the terms of the contract. In molding the massive supports of concrete, it was necessary to blast and cut through ice from five to seven feet in thickness before reaching the water. The first work

Railroad Building in Alaska

A Remarkable Railway Engineering Feat

By Day Hen Willey

Driving the Last Spike on the Copper River Line.

was to make the supports. The great piers were built of concrete by means of timber molds built through the holes cut in the ice. They were driven forty to fifty feet through the river bottom to bedrock and there anchored. Included in the concrete filling was a reinforcement of steel rods. A row of 80-pound rails was set one foot apart around each pier. Above the piers, current breakers of the same metal were placed. Before

the work was half finished water burst out from the upper glacier and the river rose twenty feet in an hour. Here was a thorough test of the piers and the breakers. They withstood the rush of the water.

The steel of the bridge was ready for erection, but there was no time to be lost. Within an hour of the time the last piece of bridge steel was piled on the bank, the first big girder was in place. Ten and one

Miles River Bridge, With Glacier Bank in the Background.

half days later the first span, 400 feet long, was completed. Nearly forty feet of steel structure a day were built with a single shift of men, day after day, through the storms and the darkness. But the second and third spans were put together faster still. The second, of 300 feet, was built in six days and the third, of 450 feet, in spite of extraordinary difficulties, in ten days. The bridge was completed except a fourth span which was over shallow water beyond the danger from ice.

Some of the adventures of these men who built the bridge across the glacial river deserve mention to show their bravery, nerve and determination. The third span of the Miles Glacier bridge was 450 feet long. The temporary foundation consisted of a thousand piles, driven deep into the bottom of the Copper River, forty feet below the surface. The ice was a solid sheet seven feet thick. Into it the piles were solidly frozen, and the bridge builders began work.

When the spring thaw had begun, the ice-cap, lifted twenty feet above its winter bed by the flood, started moving. It might be but an hour or two's work for the river to wreck the whole span. The emergency was met, as scores of others had been before. The steam from every stationary engine was driven into small feed pipes and every man in camp was put to work to steam-melt or chop the seven feet of ice clear of the piles. And it was done. The holes were kept open through days and nights of bitter cold, and the hundreds of cross-pieces unbolted and shifted while the river rose twenty-one feet. Then began the movement of the span downstream. At first it was but an inch a day; then three or four inches. The melting and chopping went on almost unceasingly. A measurement by the engineers was taken. The unfinished structure was fifteen inches out of line, and it had to be put back.

Anchorage were hastily set into the ice above the bridge. Block and tackle were rigged to them, and while a gang thawed and chopped at the ice around the piles the whole 450 feet of incomplete bridge work were dragged inch by inch back into place. The steel workers began to bolt and rivet the framework of the bridge. So rapidly did they work that the last rivet was driven after eighteen hours of continuous labor.

The span was finished just in time.

The steam traveling conveyor, an hour later, was slid to a temporary resting place on the third pier, blocks were knocked out and the third span settled on its concrete bed. At one o'clock the whole 450 feet of piling was washed out, but the bridge was intact.

This was but one of the victorious struggles against the Copper. The engineer, Mr. A. C. Hawkins, very generously gives the entire credit to the men working under him:

"They were on the job seven in the morning, no matter what the weather. They worked without ceasing till the noon whistle blew, then raced each other to the mess tent. A few minutes later they were rushing back to the work. And there they stayed until eleven or twelve at night, until flesh and blood could stand no more. It was the most amazing exhibition of loyalty, efficiency and endurance I have ever known."

There were many stretches of wooden trestle to be laid and three other steel bridges to be constructed, temporary wooden structures being temporarily substituted as a time limit of two years had been placed on the 193 miles of construction, and this meant unrelenting haste. The spring flood with its further deluges of ice-laden waters and driving rains, found many miles of sinking track, but the work was driven forward. There was track connection with a clay bed that made a good ballast, hardening like cement after it was set in place. While the construction crew and its advance guard of supply men pushed forward, the completed line was being raised several feet above the delta level, and made a permanent roadway with the clay.

The question of carrying construction material by boats was hard to solve. At first they tried towing it up the river in small boats, fifteen or more toughened river men to a boat. The river was deep, swift and icy cold; the banks of smooth boulders were often overhung with tangled cottonwoods, matted low by the deep snows. A boat ascending the river here must be "lined up." Ropes were attached fore and aft, and it was dragged through the icy water by stumbling, struggling men, while half the crew waded waist-deep in the numbing current to keep the boat off the rocks.

Temporary Track for Trains Loaded With Material and Supplies for the Copper River Bridge.

Excavation Work on One of the tunnels by Blasting in Mid-winter.

This Bridge Crosses the Kuskulana Canyon at a Height of 300 Feet Above the Lake.

Above the hundredth mile there was much heavy rockwork to be done, but the dynamiters and diggers were there to do it. Fifty miles of track laid from the western end of the bridge were deep in snow. To remove this snow and ice, a powerful rotary snow plow with two engines was operated. It made a mile and a half the first day, then disappeared, to arrive at Tickel station, fifty miles inland, thirty-one days later. Its first day's run had continued about the daily average for the entire run. In that time the rotary

plow was off the track frequently and had to be replaced.

Still another hard fight took place beyond the end of the track. Here food supplies had to be handled by sled, some thirty to eighty miles on the river to the construction camps. The river froze and thawed and overflowed. The ice piled itself into barriers, then sank away to pot-holes filled with many feet of slush and water. Hundreds of tons of brush and the work of many men failed to keep a passable sled road open.

The engineering hero who accomplished a work that seemed impossible to perform, was Erastus Hawkins of New York, who had had experience in railway building and other projects in the far Northwest. This was why he was chosen for the task here described. Exposure and hardship affected his health so that after returning to New York city, Mr. Hawkins died at his home.

Another illustration of the devotion of the engineer to his duty.

Wool Pulling*

How the Fleece is Separated from Sheep's Hides

By Robert Dantzer

THE skins from which the wool has not yet been removed, taken from sheep that have been slaughtered or have died of disease, are received in bales of different weights. The Buenos Aires bale contains about twenty dozen skins and weighs about 1,100 pounds; the Australian bale contains thirteen dozen skins and weighs 650 pounds; the bales from the Cape do not weigh over 330 pounds. Four skins are folded together with the flesh side out and placed in bales bound with wooden hoops. The Australian bale is bound with five hoops; the South American bale with seven. On each bale is marked the gross weight and the number of dozen of skins. The buyer finds it difficult to determine the yield of wool from a lot of skins. The easiest way is to open several bales, selected haphazard from the lot before the sale, and to examine the skins taken from the center of these bales. It is in the center of the bales that the smallest and least valuable skins are found. The skins are graded as follows: A, skins from sheep that have been sheared before killing. B, one quarter

strike the skin as the roller revolves. The pressure of the skin against the roller can be regulated at 10. The action of the cylinder, 9, is reinforced by a spray of water controlled by the pipe, 11, which removes the impurities. The cleaning operation can be repeated several times on the same skin, as the workman keeps hold of the end of the skin. The pedal, 12, is connected by a chain with a shipper which enables the workman to reverse the machine, causing the rollers, 1 to 6, to revolve in the reverse direction and enabling the skin to be drawn back for another operation. One man can clean about 600 skins in 10 hours. The water, although charged with impurities, can be saved if desired, but it is first passed through a metal sieve in order to save any wool that it may have carried with it. The wool thus collected is carbonized by the sulphuric acid process.

Resoaking. This operation, which is similar to the first soaking, lasts for twenty-four hours and is for the purpose of regulating the moisture. In some plants the second soaking is omitted.

Sweating. The skins, after having been drained, are placed on a truck and carried to the oven. These ovens, which are generally sunk in the ground, have each an area of from 430 to 530 square feet and are 6 feet 6 inches wide. Hooks, from 2 to 3 inches apart, are fixed on wooden rails about 5½ feet from the ground. The skins are hung on these hooks by the hind legs. The space of 1 foot between the hooks and the ceiling is necessary in order to allow for the storage of gaseous products and to expose all parts of the skin to the same temperature.

A strong odor of ammonia comes from the ovens, as a result undoubtedly of the special bacteria which exert a destructive action on the hair follicles. The care of the oven is the most important part of the operation. Much experience is necessary in order to determine the time at which the skins should be removed. If they are taken from the oven too soon the removal of the wool will be difficult. On the other hand, if the skins are left too long in the sweating house, putrefaction may set in and the skins lose their value for leather. The duration of the sweating process varies greatly and depends upon the temperature outside. It is longest in winter and shortest during stormy weather.

Classing. As they come from the sweating house the skins are of a greenish shade and very soft. They are first classified according to the length and quality of the wool.

Stripping. The wool is pulled from the skins by hand. For this purpose the skins are laid over a wooden horse, as shown at Fig. 2. The wool is then removed from the skin by means of a two-handled knife, slightly arched and having a saw tooth edge. The workman scrapes the skin with this knife and the wool is thus very easily removed. A number of boxes are placed in front of the stripping horses and the wool is sorted as fast as it is pulled from the skin. The removal of the wool from the legs offers the greatest difficulty, and in order not to injure the leather the skins are submitted to another process called:

Liming. The skins after rinsing are immersed in a large tank containing milk of lime which is agitated constantly by a series of reels running in the liquor. This process lasts for eight or ten hours. The lime destroys the hair follicles.

Scraping. This process is similar to stripping. The skin is stripped with a two-handled knife to remove all the fibers that may remain on it. This wool loaded with lime is used in the manufacture of felts. In order to prepare the skins for this operation the feet are cut off in order to obtain a uniform surface. The pieces of skin are used in the manufacture of glue. In most establishments the next process is:

Drying. The skins from which the wool has been re-

moved are hung by the legs either in the open air or in drying chambers where they are exposed to a circulation of hot air. At the end of several hours the skins are classed according to their shape and condition, after which they are offered for sale. The value of the skin in this condition depends upon the sweating process. Skins that have been damaged are used in the manufacture of glue or for parchment. To facilitate the drying process the wool is passed through iron squeeze rolls to remove the surplus water. The upper roller is covered with felt and driven by friction. The wool is then dried in a machine. In some cases the wool is first scoured, being immersed for twelve minutes in a solution of soda and soap. This solution, containing 20 per cent of soda ash and 1 per cent of soap, is prepared in iron tanks heated by steam to 120 deg. Fahr. The wool is then taken to a circular washing machine in which the water is supplied tangentially. The wool is delivered from this machine onto a

Fig. 1.

wool, one third wool, one half wool, depending on the length of the fiber. C, full fleece coming from the sheep to be killed when ready to be sheared. The wool is pulled from the skins by two methods: 1, by a sweating process; 2, by stripping.

THE SWEATING PROCESS.

Soaking. This operation is for the purpose of restoring to the skins the natural moisture lost since slaughtering the animals. It softens the skin and removes the salt added to certain skins for the purpose of preventing decay. The skins are soaked in large rectangular tanks about 26 feet long, 10 feet wide and 5 feet deep. These tanks are sunk in the ground and usually made of cement, the water being supplied at the top and run off at the bottom into a drain. When the tank is empty a workman gets into it and arranges the skins in layers. About 44 pounds of water is required for each skin, making about 10,000 pounds of water for 240 skins, the amount usually put in a tank. The skins are soaked for twelve hours in summer and forty-eight hours in winter.

Cleaning. The object of this operation is to remove the sand, straw, grass or other impurities from the wool. The cleaning machines are of different types. Fig. 1 shows the best type. The skin is laid with the wool upon the rollers, 1, 2, 3, and 4, which deliver it to the press rollers, 5 and 6. The wooden roller, 5, is corrugated. The upper roller, 6, is made of rubber and the pressure is obtained by springs, as shown. As the skin comes from the press rollers, 5 and 6, it falls on the oblique table, 7, which swings on a hinge at the lower extremity. The rubber band, 8, serves to hold the skin against the cylinder, 9. The last is provided with steel teeth or with straight steel bands which

Fig. 2.

central grating. It is then extracted to remove the surplus water and dried in a machine. It is next sorted according to length, quality and strength of the fiber. Where the wool pullery is near a combing mill the wool is taken direct to the latter establishment, because there is a tendency for the wool to become heated and the fiber injured. Some wool pulling establishments tan the skins, while others deliver them ready for tanning. In the latter case the skins are scraped on the flesh side in order to remove the grease and other impurities. They are then washed in clear water and dried in a dilute solution of sulphuric acid to precipitate the excess of lime. A second scraping is followed by a scraping of the wool side of the skin which is then ready for tanning.

THE STRIPPING PROCESS.

This method is used for French or other European skins, yielding leather of the greatest value, the wool being considered a by-product. The skins are bought by the dozen at the slaughter house while the animals are still alive. Upon their arrival at the pulling establishments the skins are subjected to the following operations:

1. **Washing.** This washing is in clear water and has for its object to remove the blood, earth and other impurities from the skin.

2. **Extracting.** This is to remove the surplus water.

3. **Soaking.** This process lasts for twenty-four hours and is similar to that already described, having for its object to soften the skins. The skins are placed on a horse and the feet and head are cut off.

4. **Cleansing.** The cleansing of the wool is effected in the manner already described.

5. **Soaking.** The skins after being cleaned by the preceding process are placed in tanks filled with water.

* Translation reproduced from the *Textile World Record*.