THE YUKON DITCH

BY

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EDITOR OF THE
MINING AND SCIENTIFIC PRESS

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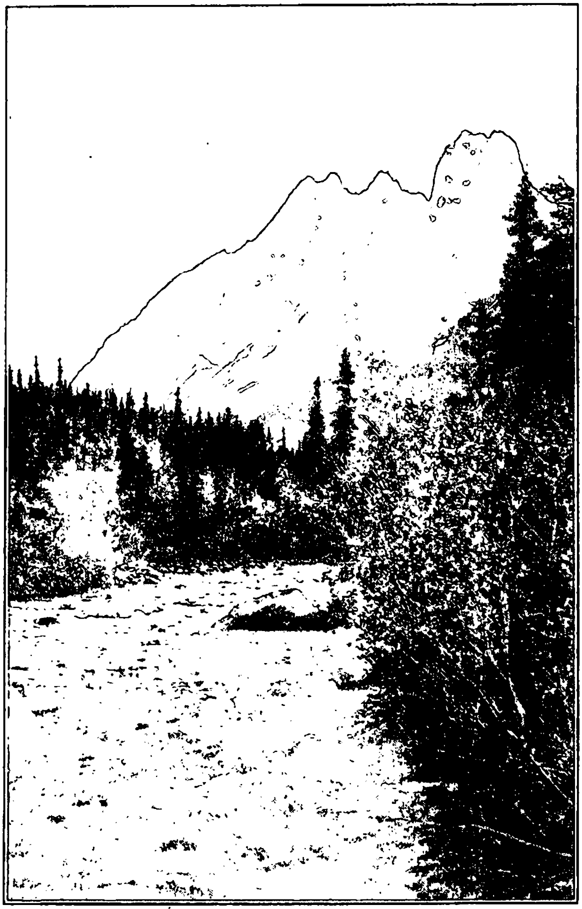
In order to facilitate the exploitation of gravel deposits situated on the Klondike river and its tributary creeks, the engineers of the Yukon Gold Co. have built a system of ditch, pipe, and flume that has a total length of a little more than 70 miles. In July 1908, it was my good fortune to observe the building of this conduit and to note some of the details of an engineering project as important as it is costly.

The country traversed by this ditch is a rolling woodland indented by the alluvial flats of the Klondike, the Twelve-Mile, and other streams flowing into the Yukon river. As seen from a height the wilderness stretches unbroken from the meandering shimmer of the Klondike, enclosed within high banks on which white scars mark bench-diggings, to the Ogilvie range, where, far to the north, the snow still lingers in token of the gift of water that shall enable man to win the gold from the deposits of gravel strewing the tortuous valleys. The engineer who first planned the line of flume, ditch, and pipe had imagination—that kind of constructive imagination which is the creative force behind all engineering work. He imagined the deed done, and then he calmly began to calculate how to accomplish it. As viewed from afar the panorama of wooded valleys, and the distant range that serves as a water-shed, afford no suggestion of the natural obstacles to be overcome, but a closer acquaintance soon demonstrates that the forest is but a scant growth of small trees, just fit for telephone poles, not big enough to yield lumber, struggling to assert a stunted life amid the vast morass covering the face of the land. A soggy blanket of moss mantles the ground, which is held in the grasp of a perpetual frost. Under the moss is ice; the moss forms an insulating blanket so that even the short warm summer does not thaw the frozen ground lying beneath this dark green coverlet. In places the ice melts slightly and pools of water form. Everywhere the surface is wet and sloppy. Our horses splashed through it. We stumbled over the spongy mass. It is a dismal swamp, which becomes almost impassable when torn by traffic. Wherever a trail was worn by use, it became a quagmire and it was best to turn our horses to the untrodden moss alongside; in this their feet would sink to a depth of 6 or 8 inches, for below that was the frozen ground; while in places, where the moss was cut and worn away, the thaw had reached deep enough to make progress impossible. And these conditions obtained not only on the flats, but on the slopes. The water is held by the moss as by a sponge, so that even over an undulating topography there were no running streams.

Roads of the corduroy type have been constructed, moss being laid on the poles and dirt on the moss. The trails traverse the brush in straight lines. Horses and men, steam and muscle, have fought against the wilderness and subdued it. The big ditch looks like a Panama canal and the steam-shovels groaning and digging in the deep cuts recall pictures of Culebra. Many of the laborers had worked on the isthmian canal, and assuredly the young engineers were as proud of the work they were accomplishing as if it were a national or even an international enterprise. The wilderness that had laid in shivering silence for untold ages, responsive only to the footfall of the moose and the cariboo, hearing only the voice of the stream and crash of the tempest, has been invaded to the very threshold of the Arctic by insistent man, determined to use Nature to his purpose, to overcome her obstacles by turning her own energy and her own power to his good in the quest for gold.

Several schemes for bringing water under pressure to the placer mines on Bonanza and Hunker creeks have been considered during the last five years. One of these involved the use of the water flowing in the Klondike river, but it was ascertained by survey that the low gradient of that stream would necessitate a ditch fully 85 miles long and an expenditure of about $7,000,000. A. N. C. Treadgold, the promoter of the enterprise now known as the Yukon Gold Co., made surveys along the tributary streams flowing into the Klondike and the Yukon from the north. Finally he applied for a right of way for a ditch to tap the head of the Twelve-Mile river. This enters the Yukon 18 miles below Dawson, and has its source in the Tombstone range, a part of the Ogilvie mountains, which rise to an altitude of 7000 ft., and gather sufficient snow to furnish a constant supply of water. It was estimated that a water conduit to the mines near Dawson, with a capacity of 125 cubic feet per second, under a head varying from 850 to 350 ft., would be 70 miles long and would cost $3,000,000. It has cost over this amount to date and will require a further expenditure to complete. The total distance between the head of the ditch and Gold hill, the point of distribution, is 70.2 miles, the difference in elevation between these points being 1112.8 ft. The effective head along Bonanza creek, in the vicinity of Gold hill, is 375 ft. The construction includes 19.6 miles of flume, 38 miles of ditch, and



THE TOMBSTONE RIVER AT THE INTAKE.

12.6 miles of pipe. Owing to the nature of the ground traversed, it has been necessary to modify the size and gradient of the ditch according to the local conditions, but the standard is a 9-ft. bottom, with $3\frac{1}{2}$-ft. depth of water, and a gradient of 6 ft. per mile, ranging from a minimum of 4 ft. to a maximum of 7 ft. per mile.

In places the ditch is fully 20 ft. wide. The standard flume is 6 ft. wide and 4 ft. deep, with a gradient of 0.2841% or 14 ft. per mile. The pipe varies according to the engineering requirements and is variously built of steel and wooden staves, so as to have a diameter ranging from 42 to 54 inches. The accompanying map shows the course of the water system and the distribution of the various forms of construction.

Wherever practicable the water is conducted by ditch, for that is the cheapest and most durable conduit. A ditch is necessarily dependent upon the contour of the surface; where depressions exist, a long detour is saved by building either a flume or pipe. If the depression is a deep ravine or a broad valley, it becomes impossible to construct a flume, and recourse is had to a pipe in U-form (forming a so-called inverted siphon), the loss of effective head being measured by the friction between the water and the sides of the pipe.

In constructing the flume, the sills of the bents are laid in good ground, that is, below the surface dirt, upon solid rock or else upon débris that will not shift after thawing. In laying pipe along a declivity the weight at the depression is taken by bents carried through the surface dirt to the gravel underneath.

The completion of this ditch in three seasons, equivalent to one full year of 12 months, is a feat highly creditable to the engineers. Owing to the large amount of money paid for mining claims, and to the heavy investment of capital involved in the building of the ditch, it was imperative that the water be brought to profitable use as speedily as possible. The first thing was to obtain power for the dredges. A sawmill was built on the right bank of the main Twelve-Mile, on a site commanding the best supply of logs. This sawmill was operated by steam-power. Then a flume 5½ miles long, 3 by 4 ft., was built on the stream known as the Little Twelve-Mile, and an electric power-plant was erected near the place where the main water-system would cross the valley and two miles above the sawmill. Meanwhile the survey for a transmission line was hastened. This was in June 1906, and it is interesting to relate that in making the survey for the pole-line the engineers worked both by day and night, the two shifts being in friendly competition; nor did the night crew complain of any handicap through poorer light. At that season the night is only two hours long, for Dawson is at latitude 64° north.

Electric transmission is effected over 36 miles of main line and 18 miles of branch high-tension line, with 8 miles of secondary lines from 4 sub-stations. The power-plant receives 60 cu. ft. of water per second under an effective head of 650 ft., the delivery

WHERE SHOVEL NO. 3 ENCOUNTERED 'FROST'.

CONSTRUCTION OF CRIBBING.

from the flume being effected by a steel pipe gradating from 36 to 34 and then to 32 in. diameter. Two Pelton wheels, actuated by a 4-in. and a 3-in. nozzle, respectively, are harnessed to two Westinghouse generators of 625 kw. each. By a three-phase system 2200 volts are stepped up to 33,000 volts, at which tension the current is transmitted over a No. 5 copper wire. A deflecting nozzle governor is an interesting feature of the Pelton wheels.

While preparations were thus being made for the transmission of power, the work on the ditch was begun. As soon as the surveys were completed, the right-of-way was cleared. The small growth of forest was removed, and the moss stripped from the frozen ground for a width of one chain (22 yards). Then steam-shovels were put to work, and while they were digging the ditch, the sawmill on the Twelve-Mile yielded the lumber needed for the construction of the flume and for other purposes. Seven million feet (board measure) of lumber was cut; this depleted the small forest available, but it proved sufficient. Electric power was employed in pulling the lumber up a tramway built from the sawmill to the site of the flume, this form of construction being confined largely to the first part of the conduit.

Without the steam-shovel it would have been hardly possible to dig the ditch in an economical manner, for manual labor at $4 per day, plus board at $2, or a total of $6 per day, is a costly instrument of engineering. Six shovels were employed. These make the cut, which is then beveled by hand, to be followed by the laying of moss on the sloping sides, with a little fine dirt as a finishing touch.

On July 19 I saw the No. 1 shovel at work on the Klondike Face. This shovel had then dug 8 miles of ditch. The machine was the Little Giant Shovel, made by the Vulcan Iron Works, of Toledo, Ohio. It weighs 36 tons and uses 45 hp. A 4-ft. extension on both the boom and dipper-handle affords 18 ft. of clearance from the centre of the track. The dipper is reinforced for this special work, and excavates 1¼ cubic yards at each swing. The machine is mounted on railroad trucks that run on a track of standard gauge. After 5 minutes of digging, the shovel is advanced, the move being accomplished in 5 to 10 minutes. The shovel was digging in soft silt requiring special treatment. Boughs of spruce were laid criss-cross upon the bottom of the cut so as to form a mattress, upon which the ties were laid, and on them the rails. The shovel dug an average of 300 ft. of ditch (9 ft. wide at the bottom) in 24 hours and had made as much as 365 ft. in a shift, the average being 1200 cu. yd. per day, and the maximum 1600 yd. per shift of 10 hours. The fuel used in the boiler was small birch that had been dried in a forest fire.

On July 21 I saw No. 3 Shovel at work on the Ballarat Division. This machine is a Model No. 20, made by the Marion Steam Shovel Co., of Marion, Ohio; it was making from 35 to 40 ft. in two shifts, but it had made a record of 680 ft. in one shift. The crew included three men on the shovel, namely, the fireman, craneman, and engineer. In the cut there were 6 men and a boss, all of whom joined forces when the time came to move forward. Two men attend to lifting-jacks and one to the blocks in the rear. The total cost of labor was $175 to $200 for the two shifts, this including a roustabout, who gathered wood, and the hauling of water for the boiler. The shovel was doing nicely in ground well adapted to a tight ditch. Progress averaged 200 ft. of ditch per shift, each foot of advance being equal, approximately, to 3½ cubic yards. On the low side of the ditch the cut was 5 ft. deep.

Shovel No. 5 was working on the Twelve-Mile Face. This machine was made by the Thew Automatic Shovel Co., of Lorain, Ohio. The State of Ohio is rich in the manufacturers of good machinery. The Thew shovel weighs 35 tons, it has a dipper of 1½ cu. yd. capacity, and a clearance of 23 ft. Owing to the ample swing, the shovel was digging a ditch 20 ft. wide at the bottom. The boom is made fast to the car-body, carrying the engine and boiler, so that the whole machine acts as a unit. It is swung on a four-wheel truck having an 8-ft. wheel-base. The shovel is not suited to soft ground, but does excellent work when digging a shallow wide ditch in moderately hard ground. The machine had made 75 ft. of advance during the forenoon of my visit and was averaging 200 ft. per day of 24 hours.

As the map shows, the aqueduct is separated into divisions, each having a name by which it is known to the engineers. A record of progress made on each division is kept by plotting the weekly advance in percentage of the total construction.

Details of construction along successive portions of the undertaking are given herewith, as gathered on the spot, by courtesy of Messrs. O. B. Perry and Chester A. Thomas, the managers.

Tombstone Creek.

41,000 ft. of 4 by 6 ft. flume.
Main intake at 3317.8 ft.

Little Twelve-Mile.

Intake of pipe	at 3199 ft.
Discharge into flume	at 3104 ft.
Lowest point	at 2459 ft.

Details of Pipe.

Length, Ft.	Material.	Diam., In.
399	Wood	49
3,540	Steel	46
429	Wood	49

Slate Creek.

32,000 ft. of 4 by 6 ft. flume.
Less 800 ft. of ditch.
Grade, 14 ft. per mile for flume, or 0.2841%.

On the Twelve-Mile Face there is about two miles of ditch in bad ground. To protect the lower bank 6000 ft. of cribbing was necessary. The grade is 4 ft. per mile. In the Nome region, where ditch construction has been more vigorous than elsewhere in Alaska or in the Yukon country, and where frozen ground obtains, some of the ditches have a grade of 3 ft. only. In a flat country such as that of the Seward Peninsula the upper bank of the ditch is not made steep and it is found best to use a ditch of wide cross-section, say 30 to 50 ft. in places. The ditch is cut to 30 ft., and becomes worn to 50 ft. As the frozen dirt thaws in concave form the moss droops over it. If the bank is not too steep nor too high the moss will hold together and eventually blanket the bank so as to hold the frost. The worst ground is that in which not only layers of ice but nearly vertical veins of ice extend through the moss and muck, so as to afford a channel for seepage as the ice thaws. These permit the water from the ditch to escape, and it will appear a hundred feet or more from the hillslope in the form of a geyser.

The next division of the Yukon ditch is on Ballarat ridge; it includes both flume and pipe construction:

Ballarat.

	Elevation.
Intake of flume (4 by 6 ft.)	at 2930 ft.
Discharge into pipe	at 2927 ft.
Length of flume, 1100 ft.	

Details of pipe (wooden stave).

Length, Ft.	Diam., In.	Staves, In.
9,300	42	1⅝
3,700	42	2½
200	42	1⅝
800	48	1⅝

Lowest point of pipe at 2543 ft.
Discharge into flume at 2769 ft.
Another length of flume, 650 ft.
Discharge at 2767 ft. Grade, 0.3%.

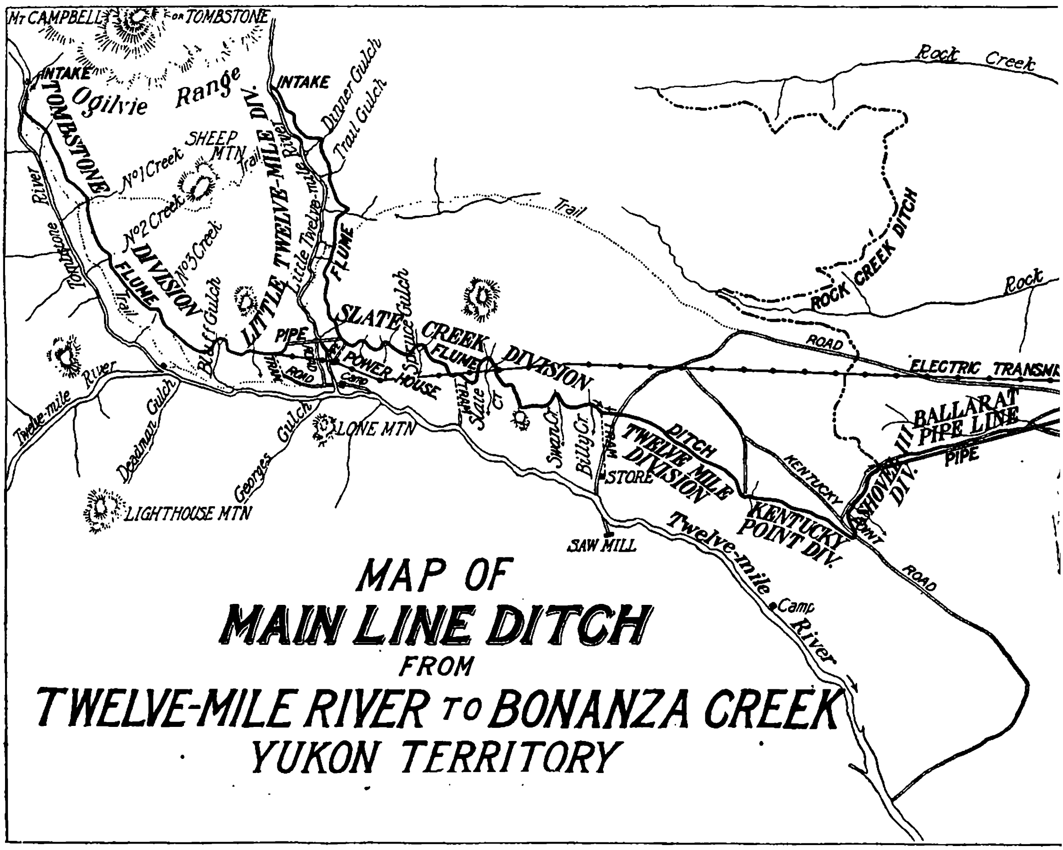
On the Ballarat ridge I watched the assembling and construction of the wooden pipe. The staves are cut to the radius arc. The butt strap, 5¼ in. wide, is a piece of band iron ⅛ by 1⅛ in. and a little longer than the width of a stave, so that the end jams into the next stave when circled by the bands. The rods are of steel. The shoes are made of malleable iron. The staves are made from 3 by 6-in. California redwood stock and planed to shape at the mill. The inside chord is 5 in. and the outside chord 5⅝ in. The pipe has 30 staves to the perimeter; each stave is of 2 by 6-in. (redwood). These are bound in ½-in. bands of round iron, tightened by means of a shoe and nut. The bands are spaced from 1⅛ in. to 10 in. apart, according to the pressure estimated; they come in the form of straight rods, and are bent to shape by being twisted round a turn-table; they are then dipped in asphaltum paint, especial care being taken to coat the shoe thoroughly. I do not know whether this was done, but it should be, as the metal forming the shoe on most stave pipe-lines I have observed is lighter than the band, and hence will succumb to the corrosive effects of the weather.

Lepine Ridge.

The wooden stave pipe follows the top of the ridge between Ballarat creek and the watershed of Rock creek. The Ballarat flows into the Twelve-Mile, which enters the Yukon at a point 18 miles below Dawson, while Rock creek joins the Klondike at 15 miles above Dawson.

Intake of flume at 2752 ft.
2600 ft. of flume at 26 ft. above ground.
Intake of pipe at 2746 ft.
Discharge of pipe at 2638 ft.
14,660 ft. of 49-in. wood pipe.
11,887 ft. built in 1907, remainder this season.
Lowest point at 2556 ft. Several sags.

The flume along Lepine ridge is carried on a trestle until a height of 26 ft. is gained, in order to get the hydrostatic head necessary for the wooden pipe of 49 in. diam., namely, 7 ft. per 1000 ft. A head of 200 ft. is about the practical limit for the wooden staves; beyond that pressure the spacing between the bands has to be so close that the steel used (in the form of bands) is almost equal to that of a steel pipe. Under excessive pressure the water squeezes the wooden staves against the bands and destroys the life of the pipe. The wooden stave pipe is furnished by the Excelsior Wooden Pipe Co. of San Francisco. The pneumatic tool equipment comes from the Chicago Pneumatic Tool Co.; and the air-compressor from the Clayton Iron Works, Chicago. In building the steel pipe-lines, instead of using the ordinary slip-joints, which are merely driven together with a ram, each joint is riveted to its neighbor, and pneumatic tools are brought into service for this work.



MAP OF
MAIN LINE DITCH
FROM
TWELVE-MILE RIVER TO BONANZA CREEK
YUKON TERRITORY

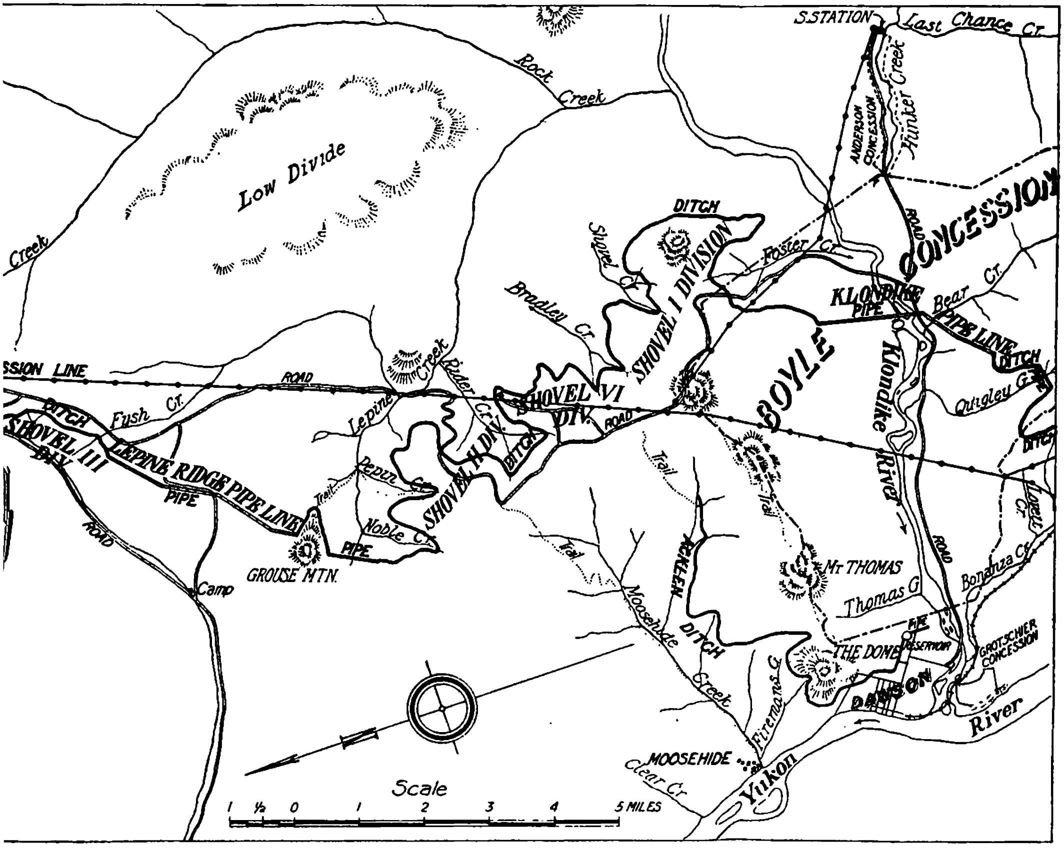
Lepine Creek.

Intake of pipe	at 2632 ft.
Discharge of pipe	at 2118 ft.
Lowest point	at 1282 ft.

Details of pipe:

Length, Ft.	Material.	Diam, In.	Thickness, In.
816	Wood	49	1⅝
2,160	Steel	47	⅜ to $^{3}/_{16}$
1,108	Wood	49	1⅝

In crossing the valley to Lepine creek it was found necessary



to sink 11 shafts to receive bents for the support of the pipe-line. The deepest of these shafts was 64 ft.; it was sunk in blue mud and wash, all frozen. The ground was thawed with a steam-point, 4 ft. at each thaw, so that the ground sank 2 ft., or 50%, after each operation. The points were spaced 3 to 4 ft. apart. Owing to the batter (2 in 12) allowed for the posts, the deepest shaft was 9 ft. long at top and 29 ft. at the bottom. The bents are made of spruce, cut from trees 45 ft. long, 6 to 8 in. at the small end and 18 to 20 in. at the big end.

The behavior of wooden pipe in the climate of the Yukon is uncertain, for the life of the material is variable, but the cost is one-third that of steel pipe. I am informed that a redwood stave-pipe of 14 in. diam. has been in use at Nome since 1900 and has given satisfaction. The pipe brings water from Moonlight springs to the City of Nome.

Klondike Pipe-Line.

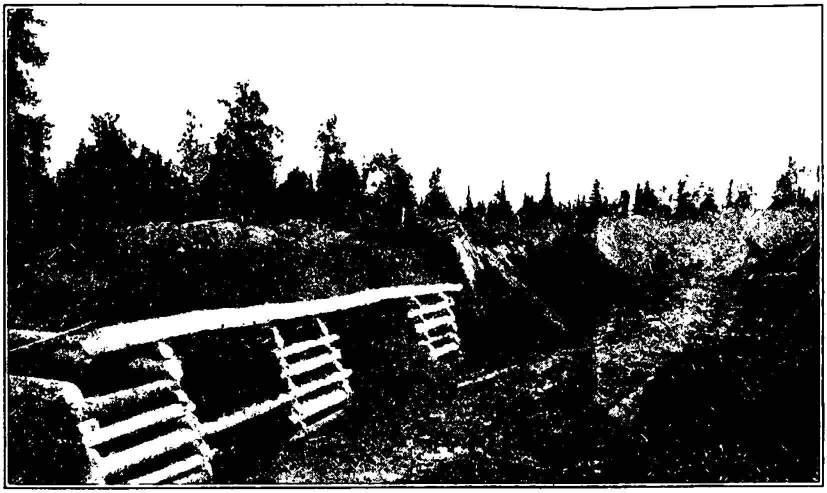
The largest single task on the whole line of construction was the installation of the inverted siphon crossing the valley of the Klondike river. The details of this line are as follows:

Intake	at 2440 ft.
Discharge	at 2240 ft.
Lowest depression	at 1282 ft.

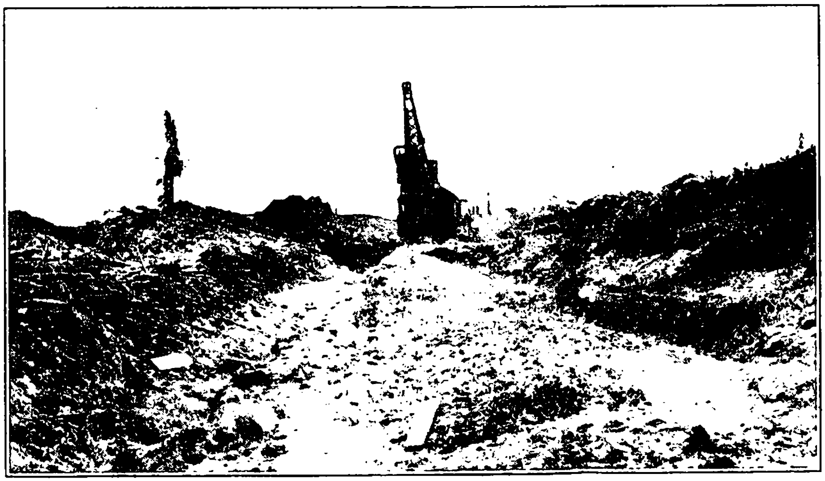
Details of pipe:

Length, Ft.	Material.	Diam., In.	Thickness, In.
760	Wood	49	1⅝
7,520	Steel	43	⅝ and 11/16
6,850	Steel	49	¼, 5/16, ⅜, ½, ⅝
1,629	Wood	49	1⅝

These data give an inadequate idea of the size of this particular undertaking. The Klondike valley is a deep wide depression, and crossing it with an inverted siphon involved the use of three miles of pipe, one mile of which is under a head varying from 1150 to 1000 ft., that is, the line had to be built to sustain a pressure of, approximately, 500 lb. per square inch. The hillsides flanking the valley are steep and this presented engineering difficulties in the way of anchorage for the heavy pipe, as well as the handling and distribution of the material. Across the Klondike flats, which overflow each spring, the pipe is supported by a system of pile-bents, each bent being composed of four heavy piles driven into the bed of the stream. In crossing the Klondike the pipe is carried by a three-span steel bridge, each span 95 ft. long, mounted on piers, erected in mid-winter. Each pier is composed of piling surrounded by mortised timber, shod with steel.



CRIBBED DITCH.



SHOVEL NO. 5 IN OPERATION.

The design and manufacture of this pipe involved the employment of engineering talent of the highest class, as practically each section of the pipe, on account of the pressure involved, had to be specially designed, and all of the bends and angles in the lap-welded portions calculated to a nicety. Practically the total length of the high-pressure portion is lap-welded pipe, furnished for the greater part by Riter & Connelley, of Pittsburg, although purchase of 1400 ft. was made in Germany. Some of the sections of the German lap-welded pipe are 36 ft. long, and weigh over four tons.

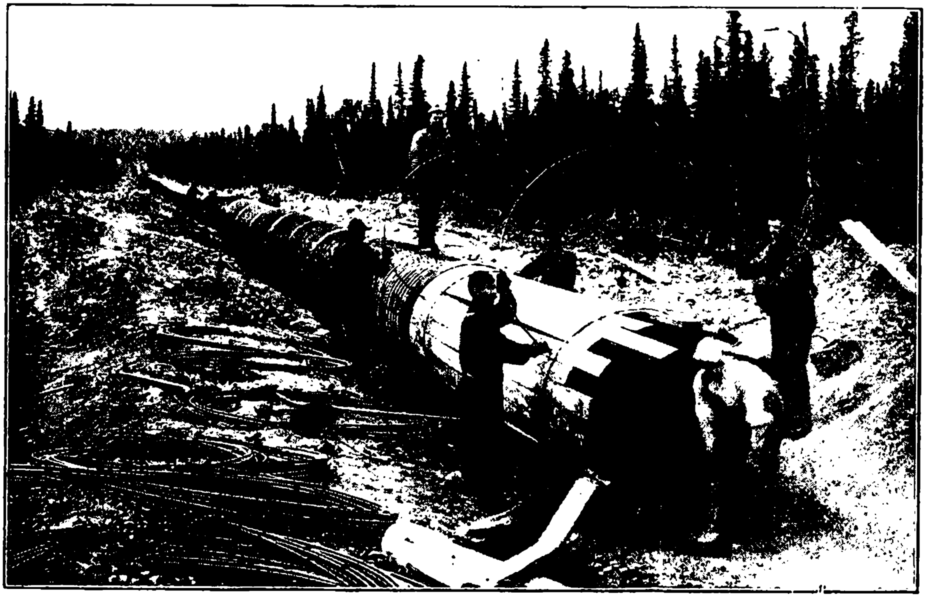
The excavation for the pipe-trench, the setting of the foundations, and the final placing and riveting together of the pipe, required the employment of over 300 men for nearly two summers, and the continual supervision of from one to three constructing engineers. The riveting and laying gangs worked day and night throughout the summer season. Five air-compressors, electrically driven, were employed on the work, as this line required to be caulked both inside and out, as well as riveted. The last rivet was driven and the line completed on October 9, 1908, thereby closing the last gap in the construction of the main ditch system as far as Lovett gulch.

In building the ditch, many natural obstacles were encountered. They were overcome by methods suggested, for the most part, by experience gathered elsewhere in the North. The following examples will prove suggestive:

1. Frozen muck, where there is material for constructing the lower bank (see Fig. 1), is scraped by the aid of horses so as to accumulate on the lower side, and against the bank thus formed poles are laid close together, the points being placed 2 ft. below the grade of the ditch. Upon the poles is spread a layer of moss or sod from 6 to 12 in. thick. Then dirt, or other good tamping material, is scraped, forming a slope 5 ft. from the toe of the moss, and inclined at an angle of 1½ to 1.

2. Fine silt or 'glacial' sand, which is frozen material that upon being exposed to the warm air, upon removal of the moss, thaws to a slime (see Fig. 2). In such material the ditch is dug 16 to 18 ft. wide, during the first season; the lower bank sloughs away; the upper bank melts, and the ditch is practically obliterated; but by maintaining open drains the whole mass is dried. In the second season the ditch is dug again, and the stuff that filled it serves to form the lower bank. Poles, moss, and fill are arranged as in No. 1. When the moss on the upper side is thick and remains unbroken, it drapes the underlying silt, which continues to run out like a thin mud until it finally attains the angle

REMOVING 'MUCK' ON TWELVE-MILE FACE.



CONSTRUCTING STAVE-PIPE ON LEPINE RIDGE.

of rest; then the moss protects the bank from further thaw. When, however, the moss of the upper bank is thin or brittle, the silt slides into the cut, and must be scraped by teams to the lower side. In cases where the lower bank is so uneven that poles cannot be laid regularly, two stringers are stretched longitudinally to

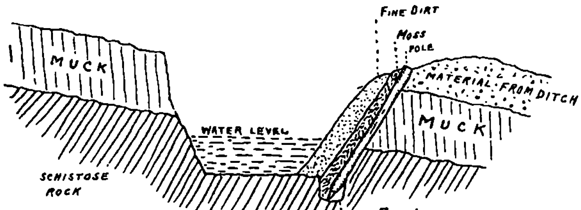


FIG. 1
TRENCH DUG 2FT BELOW GRADE

FIG 2

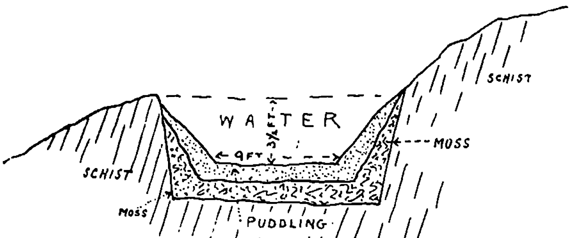


FIG 3

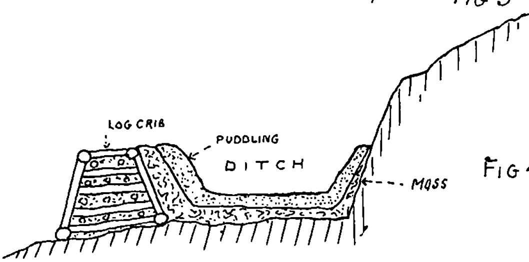
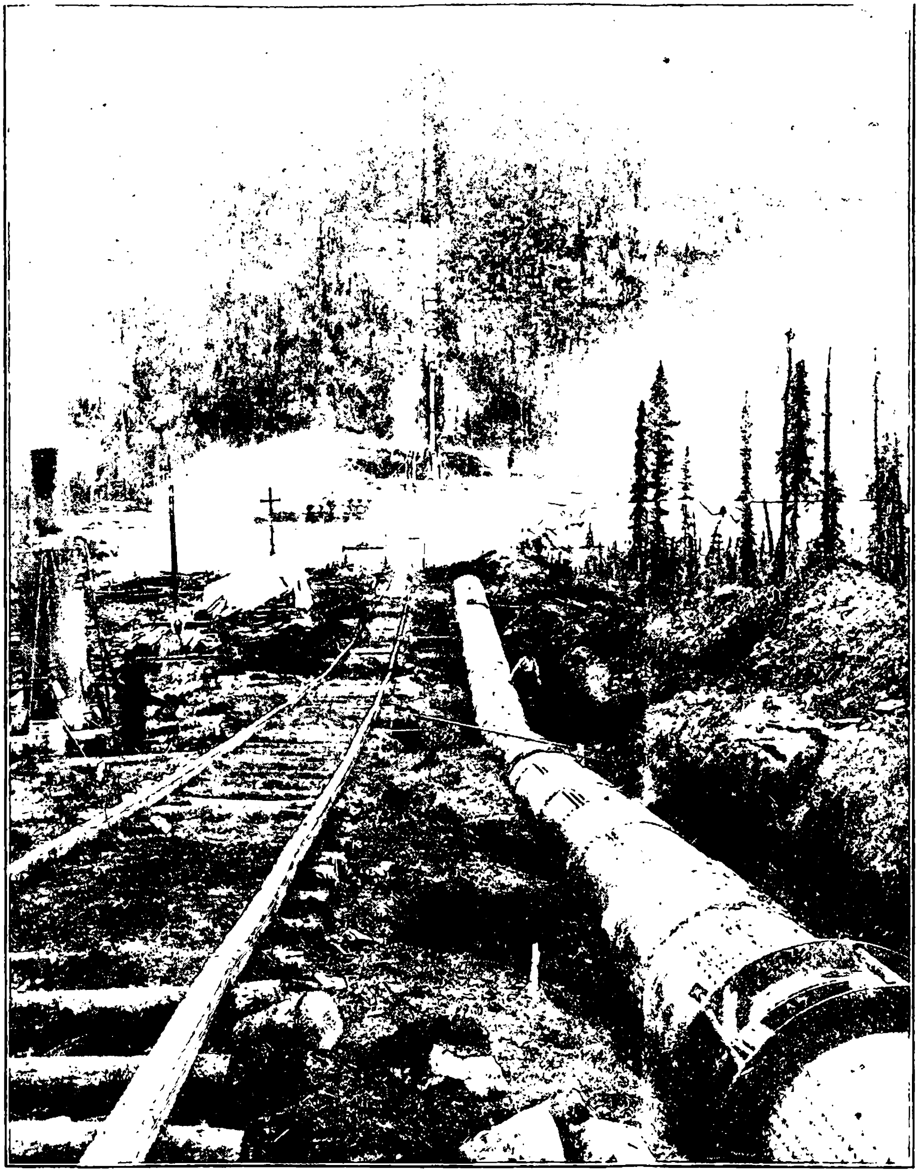


FIG 4

serve as a base for the poles. These stringers are held in place by logs placed horizontally underneath the lower bank.

3. Shattered schist (see Fig. 3) is easy to dig, but it makes leaky ground. Digging is done by the steam-shovel and the ditch is made 14 ft. wide at the bottom. The corners are excavated by hand-labor, and filled with moss to a depth of at least 12 in. The bottom of the ditch is also blanketed with a foot of moss. On top



DISCHARGE END OF PIPE ON THE LITTLE TWELVE-MILE CREEK.

of this is spread a covering (8 to 12 in. thick) of good puddling dirt, and the sides are given a slope of $1\frac{1}{2}$ to 1.

4. A rocky slope, with no lower bank (see Fig. 4) offers another problem. On the lower side a crib of logs is built, with a base 6 ft. wide, and a top 4 ft. wide. This framework is filled with broken rock. Moss and puddling are applied as before.

It was no light task to take care of the men engaged in this work; they were scattered over a line reaching more than 50 miles from Dawson, the various camps being pitched in a wilderness of scrub and soggy moss. No supplies, either of food or material, are hauled in summer, for all the roads except those built by the Government near Dawson, are then impassable by heavy wagons. Hauling is done exclusively in winter. The stumps and brush are cleared in a line across the marsh and as soon as the frost comes a passage is effected. A plow removes any excess of snow, and the road is watered so as to give it a durable crust of ice. Logging-sleds from Michigan are used; the average load is 9 tons with 4 horses, and 11 tons with 6 horses. The maximum load is 15 tons, with 6 horses. It cost $2000 to set up a camp, and it cost $7000 to $12,000 to get a steam-shovel ready to work. Not less than $75,000 worth of horses were employed, the price at Dawson being $800 to $900 per pair.

The magnitude of the work accomplished by the engineers of the Yukon Gold Co. may be inferred from an enumeration of the tasks completed during the three seasons since the first surveys were finished: 7 dredges in commission; 3 mechanical elevators; a dam and reservoir (700 miner's inches for 40 days) on Bonanza creek, connecting ditches, flume, and pipe (aggregating 9 miles); a power-plant of 2000 hp., with 36 miles of main line, 18 miles of branch, and 8 miles of secondary lines; 64 miles of main ditch, flume, and pipe of 5000 in. capacity. All this has been done 3500 miles distant from manufacturing centres, with an inadequate supply of labor. Some of the machinery that arrived at the time of my visit had been ordered 18 months previously. The company was carrying 1812 men on its pay-roll, representing from 1600 to 1700 men continuously engaged. This called for an expenditure of $300,000 per month. In the examination of the claims purchased or optioned not less than $55,000 was spent. During the season of 1907 over 7000 tons of material was received, and it was inevitable that some of the parts ordered in advance, for immediate operations, should be delayed in delivery despite every effort. It is always difficult to operate when also engaged in construction work on a large scale. Moreover, some of the work was experimental, and the charges for this had to be absorbed concurrently with the capital expenditures. Of the 4 large dredges, 2 are of Bucyrus and 2 are of Marion manufacture, each couple being of the same pattern, so that the parts are interchangeable. The 3 smaller dredges were built by the Bucyrus company; they are of identical design and entirely interchangeable.

FINISHED DITCH, BEFORE WATER IS ADMITTED.

A sufficient stock of parts is carried, so as to obviate delays from slowness of transport. Maintenance of a proper commissariat for laborers scattered over an area 70 miles long by 30 miles wide, required some generalship. Laborers get $4 per diem and board, the latter costing the company from $1.75 to $2. An effort was made to overcome the uncertain supply of local labor by importing 320 men from British Columbia. Of these 20 deserted on the way. Owing to the shortness of the season, to the expense of travel, and to the opportunities for individual mining, it is difficult to keep intact a force adequate for so large an engineering work.

The supervision has been in the heads and hands of young men, mostly graduates from mining schools. The chief, O. B. Perry, is a graduate of the Columbia School of Mines; the resident manager, Chester A. Thomas, hails from Stanford University; the superintendent of dredges, E. E. McCarthy, is a Harvard man; C. G. Newton, in charge of pipe-line construction, is a Michigan graduate; the head of the hydraulic mining, George T. Coffey, is a graduate from the school of experience. Berkeley contributes two or three good men, but for obvious reasons Stanford is more largely represented; for example, H. H. Hall and E. A. Austin hail from Stanford. Most of these men range between 25 and 33 years of age, with a few youngsters, but it was noticeable that even the chiefs of divisions were not much over 30. They constitute a fine body of young and vigorous men, willing to make the most of the long Arctic day, and eager to hasten a work of which it can be said that it is the most interesting example of man's invasion of the trackless wilderness that borders the Arctic Circle.

O. B. Perry. C. A. Thomas. W. F. Copeland.
C. G. Newton. T. A. Rickard.