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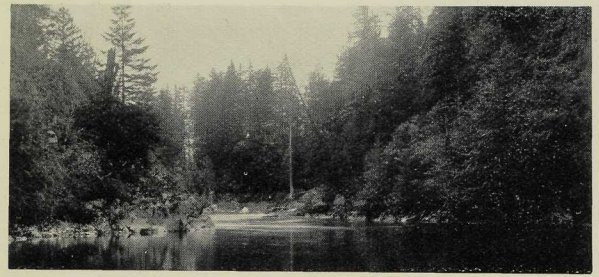
THE RUSKIN HYDRO-ELECTRIC POWER DEVELOPMENT

BRITISH COLUMBIA ELECTRIC RAILWAY COMPANY
LIMITED

W. G. MURRIN, *President*

VANCOUVER, BRITISH COLUMBIA

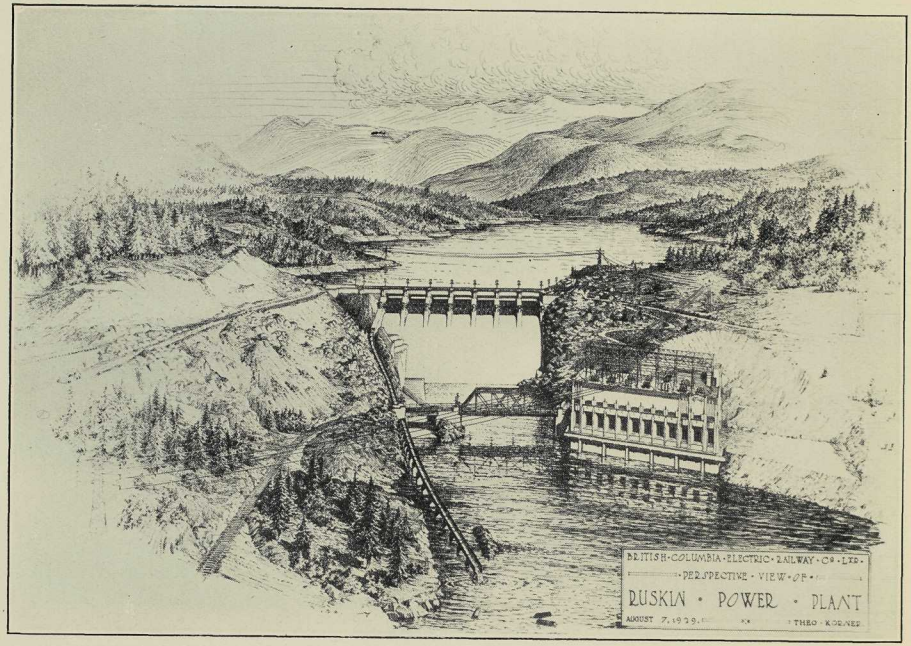
ALOUETTE
POWER PLANT
ALOUETTE LAKE
STAVE
LAKE
STAVE FALLS
POWER PLANT
NEW RUSKIN
POWER PLANT
FRASER RIVER



IN its journey from Stave lake to the Fraser river, the water of the Stave river falls a total distance of 269 feet. Approximately, only half of this fall is at present utilized, namely, in the Stave Falls power plant, six miles north of the Fraser river at Ruskin. It has always been realized that there remained a potential water power three and a half miles below Stave Falls, where the other half of this "head" of water could be harnessed.

The development of this second plant on the Stave river, known as the Ruskin development, is now under way, having been begun in March, 1929. It will utilize all the fall in the water from the time it leaves the turbines in the Stave Falls plant until it reaches tidal water in the Fraser river. The dam being built at the Ruskin development will back the water up to the tail race of the Stave Falls plant, forming a lake three and a half miles long.

All water power developments consist, first, of a means for damming or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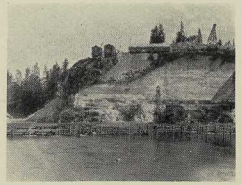
PERSPECTIVE·VIEW·OF·
RUSKIN · POWER · PLANT
AUGUST 7, 1929.
THEO·KOERNER

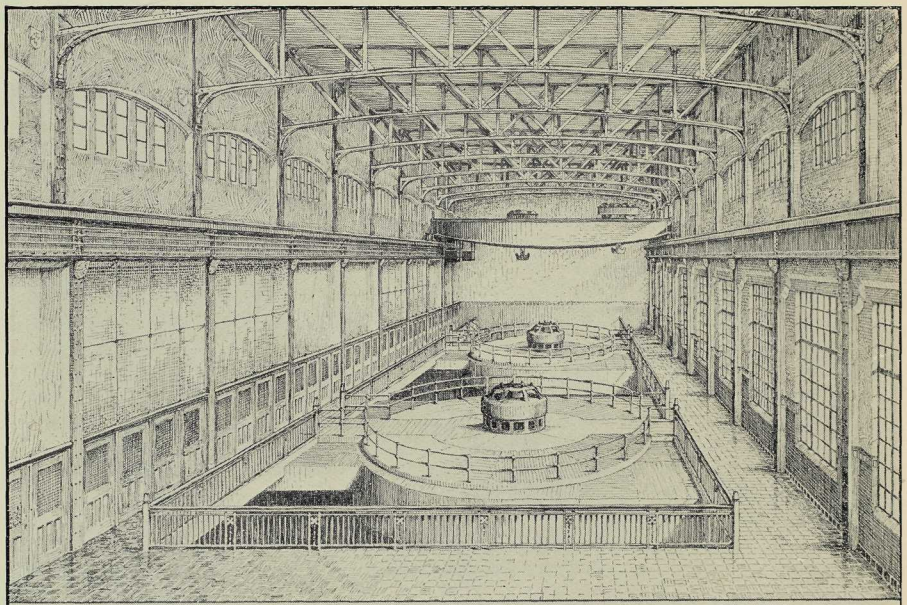
diverting the water from its natural course to the power plant, second, tunnels or pipes for conveying the water from the river or lake to the water wheels and, third, the power house itself, consisting of these water wheels, generators and the necessary transforming equipment.

One of nature's strange whims is seen in the formation of the gorge where the Ruskin dam will soon be built. After meandering through the terraced valley below Stave Falls, the river has cut its way deeply through a rock barrier that once blocked its course. From there it debouches into the flood plain of the Fraser river a little above tide level. Strangely enough, in cutting a way through the morainal barrier in its path, the river waters ignored the softer zones of glacial outwash that flanked and probably covered a spur of bedrock, and started to form its new channel by cutting in a quartering direction into the solid rock. Once started, it continued its erosion and the formation of the Ruskin gorge, some 160 feet deep, with abrupt walls on each side, has resulted.

The site has no contributing watershed as such, the water being drawn from the tail race of Stave Falls. The reservoir which will be formed by the construction of a massive dam will therefore function only as a forebay to regulate these waters and only daily regulation will be possible. It will be 700 acres in extent.

The "head" of the water available for power development will be approximately 130 feet, which is the total fall between the tail-race of the Stave Falls plant and the average height of water below the dam. The dam will make available in one spot the fall which takes place over a distance of three and a half miles. Owing to fluctuations in the flood levels of





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the Fraser River as well as tidal variations, the available "head" will vary from time to time.

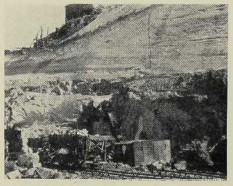
The power plant will be situated on the east side of the river immediately below the dam. At a point on the east bank upstream from the dam, the water will be diverted by means of tunnels to the power house. One tunnel will be driven for each turbine. There will ultimately be four of such units and therefore four tunnels.

The initial installation will consist of one unit, generating 47,000 horse-power, but the power house will be made large enough to permit the installation of a second unit and the tunnel for conveying water to this second unit will also be driven at this time.

It will thus be seen that the total capacity of the Ruskin plant will be 188,000 horse-power when it reaches its ultimate state of completion.

The main dam will be of concrete, the crest acting as a spillway in case of high water. In the spillway bays of the crest, seven regulating gates will be set between piers supporting a roadway from which the gates will be operated. The dam will be 400 feet long on the crest and 185 feet in maximum height from its foundations and will contain 87,000 cubic yards of concrete.

Approximately 35,000 yards of loose rock, boulders and top bedrock will be excavated to prepare the foundation for the dam. These excavations will have a maximum depth of 35 feet. Two cofferdams, one at the upstream face and one at the downstream, will be required to divert the river while excavations for the main dam are being made. To permit the passage

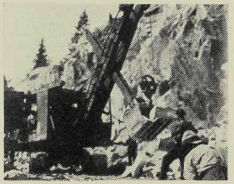


of the 7,000 cubic feet per second of water which flows down the river at times, it was first necessary to blast a way for a flume, 36 feet in width by 12 feet deep. The cofferdam on the upstream side of the dam-site will divert the stream into this flume thus leaving the bed of the river dry.

To convey the heavy machinery across the river into the power house, a bridge carrying standard gauge railway tracks must be built.

It is interesting to note that the generators will be among the largest in dimensions on this continent. With vertical axis, these generators will be no less than 33 feet in diameter. The total height from the bottom of the draft tube to the top of the unit will be no less than 65 feet. The foundations of the power house will go down 30 feet below the normal water level of the river. A cofferdam will be built to hold back the water while excavations are going on.

The contract for the dam, which is the largest single contract in the Ruskin project, was let on February 21, 1929, to the Vancouver firm of Stuart Cameron and Company associated with Armstrong and Morrison. This work includes the construction of the dam, the lower portion of the reconstruction of the Stave Falls railway and the excavation of the tunnel intakes. Cement, gates and other materials and equipment supplied by the B.C. Electric company will bring the total cost of the dam up to $1,800,000.



The flooding of the area above the canyon will bring the road and the Stave Falls railway line under water. It was therefore necessary to relocate both road and railway, contract for which work was let on March 16, 1929, to Ellis-Cotton Limited for $135,000. The contract for the 44,000

kva generator was let on April 2 to the Canadian Westinghouse company for $427,000. This generator will be of the vertical type and its size is worthy of note. The rotating portion will be 27 feet 10 inches in diameter and the "stator" will be 33 feet in diameter. The weight of the revolving part will be 550,000 pounds and the total weight of the unit will be 800,000 pounds. The vertical reaction type Francis turbine will be furnished by the Dominion Engineering works at a contract price of $138,000. The total weight of this unit will be 590,000 pounds and the weight of the revolving parts 97,000 pounds.

The weight of the rotating parts of the generator and turbine together with the hydraulic thrust will be close to one million pounds, which must be sustained by a single thrust bearing, while revolving at a speed of 120 revolutions per minute.

The main step-up transformers, four in number, will be furnished by the Canadian General Electric company at a total cost of $109,000. These transformers will have a height of 19 feet 4 inches and a diameter of over 8 feet. The total weight of each transformer will be 86,500 pounds. This contract was awarded on April 11. The contract for the bridge connecting the power house with the Stave Falls railway as well as the span across the diversion flume was let to the Dominion Bridge company for $17,500. Contract for the penstock and power house substructure was let on April 13 to Stuart Cameron and Company for $345,000.

It will be seen from these contracts that more than $2,000,000 worth of work was awarded between February 21 and April 13, a period of seven weeks.

It is expected that the present development, consisting

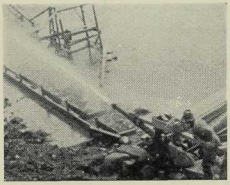
of one unit, will be completed and transmitting power to Vancouver by September, 1930.

The Ruskin plant will use the same water as has passed through the Stave Falls plant, with its capacity of 72,500 horse-power. Some of the water has also passed through the Alouette plant, which develops 12,100 horse-power.

It may be wondered why the Ruskin plant, using the same water and with approximately the same head as the Stave Falls plant, should be designed to develop 188,000 horse-power compared with only 72,500 horse-power for the latter.

That is because the Ruskin plant will be what is known as a "peak load plant." It will be primarily for taking care of the "peaks" in demand and thus will not be in use as many hours as another plant would be. The quantity of water in storage behind the dam can therefore be used faster per hour because the total number of hours use per day will be less.

The "mean" flow of the Stave river is 4,200 cubic feet per second; the Stave Falls plant, when fully loaded, discharges 7,200 cubic feet a second, but when the Ruskin plant is completed and operating at full capacity it will draw water from the reservoir at the rate of 14,000 cubic feet per second. To operate continuously at this rate would, of course, be impossible as the reservoir would quickly be depleted. With the Stave Falls plant running, the Ruskin plant, at full capacity, will pull down the level of the reservoir at the rate of six inches an hour.



In round figures, the Stave Falls plant has a capacity of 280,000,000 kilowatt hours a year. The Ruskin plant having no additional watershed and depending upon the same

water but at a slightly greater head, has a capacity of 315,000,000 kilowatt hours a year.

The Ruskin plant, in view of its proximity to Vancouver, will also be in the nature of a standby plant which can take care of a heavy load for a short time in the event of a transmission line from one of the other plants being out of commission.

The additional power from the Ruskin plant will call for additional transmission lines. These arteries along which flows the essential current for the factories, homes and electric railways of Vancouver and the lower mainland must be of sufficient capacity and so diversified that a breakdown of every line is a most remote contingency. At present there are two high tension lines from Stave Falls and one under construction on the north bank of the Fraser river. It is planned to build two more high-tension lines on the south bank so as to be entirely independent of those on the north bank. Eventually there will be eight high-tension lines from the joint Alouette-Stave-Ruskin development and "tie-lines" between each plant will enable current to be sent over any or all routes from any plant.

The additional power from Ruskin will require additional receiving apparatus near Vancouver. Bridge River power will be received at the Horne-Payne receiving station, but Ruskin power will be received at the Burnaby substation, near Edmonds, which will be enlarged for the purpose.

Contrasted with the Ruskin plant, the Bridge river development now proceeding on Seton lake, 135 miles north of Vancouver, will be a "base power" source. Because of the

volume of water available at a head of 1200 feet, this plant will be used for the base load or the continuous demand—in conjunction, of course, with the other plants in the B.C. Electric system.

The mainland system of the B.C. Electric Railway company at present develops 157,200 horse-power made up as follows:

Lake Buntzen plants 1 and 2 - - -	57,500	horse-power
Stave Falls plant - - - - - -	72,500	" "
Alouette plant - - - - - - - -	12,100	" "
Steam standby plant - - - - - -	15,100	" "
Total	157,200	" "

The addition of Ruskin and Bridge river will bring up the total as follows:

Ruskin, 1930 - - - - - - - -	47,000	horse-power
Bridge River, 1932 - - - - - -	54,000	" "
Total	101,000	" "

Total development by 1932, 258,200 horse-power.

The growth in demand for electrical energy is constantly a matter for close study by the engineers. Estimates of future growth are based upon charts which show the average rate of increase in the past. Such charts for Vancouver and the lower mainland indicate an average increase in the demand for electrical energy of 12 per cent. per annum compounded. This means that the demand doubles in between six and seven years.

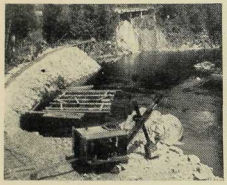
A Huge Programme of Expenditure

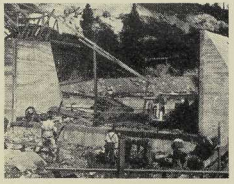
As the present peak demand is approximately 135,000 horse-power, it will be seen that provision must be made for 270,000 horse-power by 1936 and 540,000 horse-power by 1943.

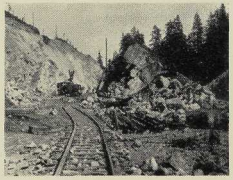
It is on such a programme that the British Columbia Electric Railway company is now embarked, with its attendant enormous capital outlay. An estimate of the expenditures the company is committed to or contemplates at Ruskin and Bridge river is as follows:

Ruskin, first stage, 1930 - - - - - - -	$ 7,226,000
Bridge, first stage, 1932 - - - - - - -	14,000,000
Ruskin, second stage, 1934 - - - - - -	1,854,000
Bridge, second stage, 1936 - - - - - -	3,218,000
Total	$26,298,000

At the same time, the distribution system must similarly be extended as it is estimated that for every two dollars spent on development, one must be spent on distribution. It will be seen that nearly $40,000,000 will be necessary for electrical development within the next seven years, or about $6,000,000 a year.





THE RUSKIN POWER DEVELOPMENT AT A GLANCE

Capacity of first unit - - - - -	47,000 horse-power
Ultimate capacity of plant (four units)	188,000 " "
Cost of first stage - - - - - - - - -	$7,226,000
Cost of second unit added - - - - -	1,845,000
Distance from Vancouver by transmission line - -	30 miles
Height of dam - - - - - - - - - -	185 feet
Length of dam at crest - - - - - -	400 feet
Amount of excavation:	
Dam - - - - - - - -	110,000 cubic yards
Power House - - - - -	36,000 " "
Amount of concrete in dam - - -	92,000 " "
Diameter of tunnels - - - - - - - - -	21 feet
Amount of cement required - - - -	150,000 barrels
Capacity diversion flume - -	8,000 cubic feet per second
Initial transmission line to Vancouver	2—60,000 volt circuits
Ultimate transmission line to Vancouver	4—60,000 volt circuits