THE ENGINEERING INSTITUTE OF CANADA
and its member societies

L'Institut canadien des ingénieurs
et ses sociétés membres

EIC's Historical Notes and Papers Collection

(Compilation of Articles, Notes and Papers originally published as
EIC Articles, Cedar Grove Series, and EIC Working Papers)

ENGINEERING HISTORY PAPER #19

"Historical Extracts from Papers Published in the Engineering Journal"

Compiled by Andrew H. Wilson

(previously published as EIC Working Paper 7/1998 – May 1998)

****

EIC HISTORY AND ARCHIVES

****

PO Box 40140, Ottawa ON K1V 0W8
+1 (613) 400-1786 / admin.officer@eic-ici.ca / http://www.eic-ici.ca

Abstract

This is the third in a sub-series of EIC Working Papers that examines the role of the Engineering Journal, which was published by the Institute from 1918 until 1987. The first of them discussed highlights from the Journal's own history.(1) The second considered a number of the technical papers and articles that appeared in it over the years in terms of three categories: those that were of historical interest at the time of publication; those that acquired historical interest after publication; and those that could well be of historical interest sometime in the future. It also looked briefly at the Journal's reporting of the development of the Institute itself.(2) This third Paper provides extracts from six of the technical papers and articles included in the first of the categories above as a means of illustrating the scope and variety of the material that may be found in it.

The six extracts have been arranged in rough chronological order of the material they discuss, although there is a good deal of overlapping. The material in the five of the six is principally concerned with engineering in the 19th century.

The first of them is "Early Ottawa and Engineering" by Robert F. Legget, which was published in the February 1961 issue of the Journal (page 1). It covers the development of the city from, roughly, 1820 to 1890, including work associated with the Rideau Canal. The second is "The Past: A Chronology of Early Canadian Engineering Activities" by J.G.G. Kerry and was published in the August 1974 issue (page 9). It, too, begins around 1820 but continues on until the early years of the present century, covering principally the building of canals and railways and some of the outstanding early projects in Eastern and Western Canada. The third, and the only one written by a non-engineer, is "William R. Casey: The Forgotten Engineer" by John Beswarick Thompson (page 16). It appeared in the January/February 1971 issue. Casey, an American, was the engineer who supervised the building of Canada's first public railway - the Champlain and St. Lawrence - in the 1830s, but who died in 1846 at the age of 38. As a result, he is usually forgotten when the pioneering railway engineers in Canada are recalled.

The fourth extract is from the paper "The Development of the Steam Engine in the Maritime Provinces of Canada" by D.W. Robb, which was in the October 1920 issue of the Journal (page 19). The engines in question were for marine, locomotive and stationary applications, and most were built between 1840 and 1890. The fifth extract is from the same issue, "Reminiscences: Pioneer Life in the West" by H.J. Cambie (page 23). It is less concerned with engineering than with the environment in which the railway engineer of the late 19th century often travelled and worked. The final - mostly 20th century - extract is from the paper by R.L. Hearn describing "Canadian Hydro Electric Developments on the Niagara River." (page 28) It deals principally with the period between 1895 and 1920.

Only two of the illustrations that appeared in the original papers - along with a third from another source - have been reproduced in this one. Biographical notes on the six authors - and their photographs - can be found on pages 34 and 37 at the end of this Paper.

About the Compiler

For the past several years, Andrew H. Wilson has been reviewing the various issues of the Engineering Journal for their contributions to the history of engineering and to the development of the Institute itself. His educational background has been in engineering, economics and history, which he has applied to practice and research over a working career that began in the 1940s and continues today. His contributions to the history of engineering have been made principally through the Institute and the Canadian Society for Mechanical Engineering.

About the Working Paper Series

In June 1995 the Council of the Institute agreed that a series of Working Papers on topics related to its history and development, to the history and development of other institutions serving engineering in Canada, and to engineering generally, should be published from time to time. The Papers may or may not be authored by members of the engineering profession.

The Papers will have limited initial distribution, but a supply will be maintained at EIC Headquarters in Ottawa for distribution on request. They may be published again, later, in whole or in part, in other vehicles, but this cannot be done without the expressed permission of the Engineering Institute of Canada. The Series will be administered by the EIC Executive Director and by the Secretary for EIC History and Archives.

The opinions expressed in the Papers are those of the authors and are not necessarily shared by the Institute.

Note to the Reader

The compiler's principal task has been to decide which parts of the original papers should be extracted for the purposes of this present one. The original styles and editing have been preserved as much as possible although a few corrections have been made. To distinguish, in what follows, between the original texts and *the compiler's comments, the corrections, the notes and references, and the biographical notes, the latter have been italicised.*

From the February 1961 issue:

Early Ottawa and Engineering
by Robert F. Legget

The text that follows represents almost all of the original one. The omissions are principally descriptions of geography, history and biography that add only marginally to the engineering 'message' the author has conveyed. A diagram illustrating the chronological development of Ottawa and its population can be found on page 4.

The city does occupy a lovely location, but the city of today stands where it does mainly because it occupies the site of an early construction camp, built on a clearing in the virgin forest, its location determined by the start of a military canal that is still a notable engineering undertaking. This is but one of the close links between early Ottawa and early engineering work....

...it can be said of Ottawa that its immediate area does include the confluence of three important rivers, the Ottawa, the Rideau and the Gatineau, all of which have had their influence on its development. First and foremost is the Ottawa, one of the truly historic waterways of North America, providing the main route to the interior of most of this continent for almost all of the early explorers.

It was in 1613 that Champlain saw and described the lovely falls of the Rideau River, as he approached the Chaudière *(Falls, on the Ottawa)*, there to disembark and follow the two short portages on the north bank of the river, long used by the Indians. As the continent was explored, he was followed by a steadily increasing stream of travellers, the Ottawa being used in preference ot the St. Lawrence as the more direct toute to the upper lakes and to the north....And in the very early use of this famous portage, unknown voyageurs, anxious to make their traverse a little easier, constructed what can accurately be described as the first Ottawa engineering project - four or five sets of stone steps and a small stone causeway near the up-stream end of the Second (or Little) Chaudière Portage. Largely through the efforts of the two Canadian Clubs of Ottawa, these histroic relics have been preserved in place, as a national historic site, just as they were used through the years....

Philemon Wright, a shrewd and energetic Yankee from Woburn, Mass., saw the possibility *(of forming a settlement adjacent to the Chaurière Falls)*...on his third journey north of the border, with the result that in February 1800 he left his home town with his family and some associates, arriving in March at the Chaudière, there to settle on the north bank, thus founding what is today the modern city of Hull. The first settlers in the Ottawa Valley had come a few years before, starting in 1791, but they were still scattered and isolated when Wright, with the aid of his sons, set about clearing his land....

By 1826, Philemon Wright had cleared 3,000 acres; Hull was a thriving little community. The south side of the river, however, was still almost untouched virgin forest...Such was the site of the modern city, when early in September of that year, the Earl of Dalhousie, Governor-in-Chief, accompanied by a middle-aged officer of the Royal Engineers, and their aides, sailed up the river from Montreal, to be greeted warmly by Wright. They had come to select the site for the entrance to the Rideau Canal, the British Government having finally decided that this vital link in the alternative route between Montreal and the fortress of Kingston must be built, even though the government of Upper Canada had declared itself too poor to contribute to the cost....

The Engineer Officer was Lieut. Col. John By, selected almost certainly by the Duke of Wellington himself to be the Superintending Engineer on this great work. By and the Earl of Dalhousie inspected the site proposed by the Governor for the canal entrance, and agreed upon the first steps to be taken towards construction...One year later the 'corner stone' for the locks was laid by the Countess of Dalhousie...on September 29, 1827. Less than five years later, on May 29, 1832, Colonel By now accompanied by his wife and two daughters and fellow officers came back to the same spot, but this time on board the little steamer Pumper (renamed Rideau for the occasion), at the conclusion of the first voyage through the completed canal, starting at Kingston Mills....

Faithfully indeed did the Superintending Engineer carry out his assigned tasks....He reserved for the use of government the site now known as Parliament Hill. He laid out unusually broad streets, with the cooperation of Nicholas Sparks;...he started essential municipal services. His construction work is seen in the canal of today, with its flight of entrance locks and those at Hartwells and Hog's Back, where By's great dam is now the core of the modern structure. He flooded Dow's great swamp in a singularly bold piece of engineering,...constructing one of the first large earth dams in North America for this purpose.... And on the site of his construction yard and main workshops *(now)* stands the Chateau Laurier. Rarely has the construction of one engineering project been so directly responsible for the start of a city as was the Rideau Canal for Ottawa....

At a dinner held in 1827, it had been suggested almost jocularly that the settlement, officially first called Rideau Canal, should be named Bytown. The name was quickly adopted for official use; as Bytown the city was incorporated and remained as such until 1855 when Ottawa was adopted as the new official name....

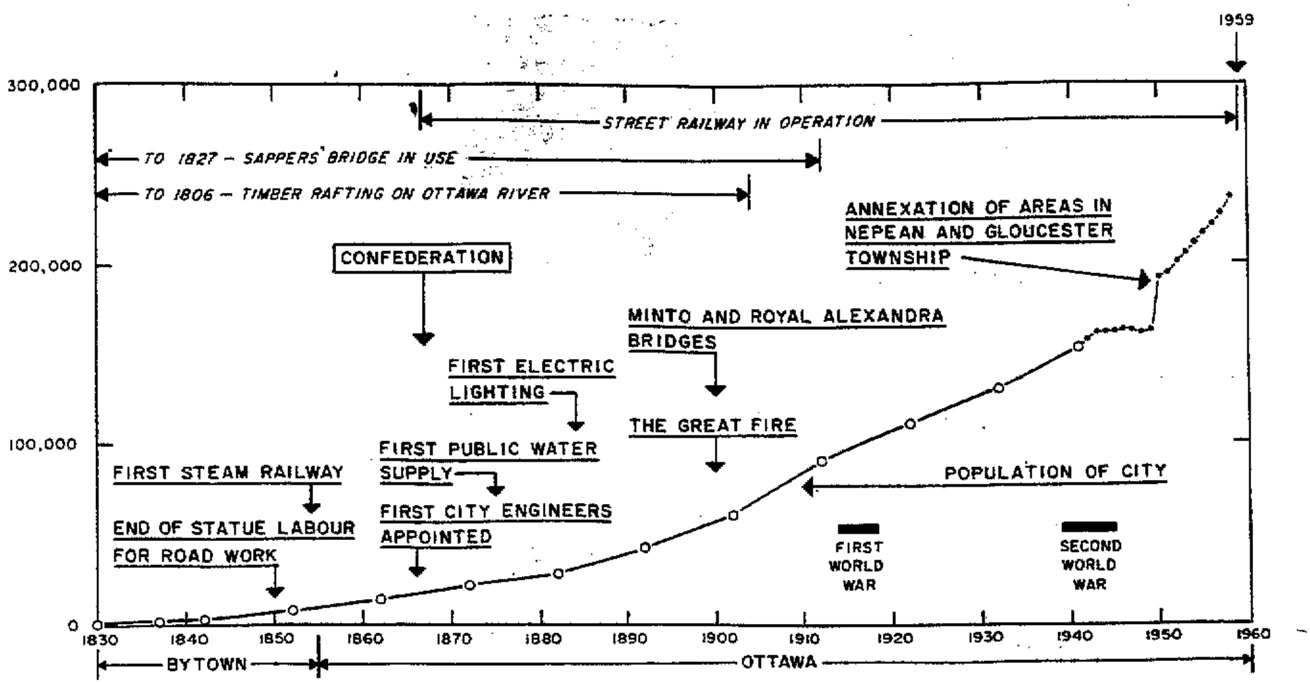
The canal did serve its intended purpose of conveying troops and military supplies, even though most fortunately these were not needed for actual warfare. But civilian traffic on the canal increased rapidly; the merchants of Montreal were not slow to see the advantages of shipping their goods to Upper Canada by the new route, with the result that within a few years there was a regular and frequent service on what became known as the 'Triangle Route' - Montreal, up the Ottawa, the Rideau Canal to Kingston, and back to Montreal down the St. Lawrence. Only when the first steamer reached Kingston by way of the finally completed St. Lawrence Canals, in 1855, did the Rideau route cease to be in fact, if not in name, the first St. Lawrence Seaway....

Passengers on the Ottawa River steamers would see not only river traffic provided by other steamers and barges, but the special Ottawa River traffic consisting of rafts of squared timbers. The magnificent stands of white pine throughout the Ottawa Valley attracted early attention, to such an extent that they soon became a major source of supply for the British Navy in its great days of wooden warships. Philemon Wright was responsible for the first raft of timber to go down the Ottawa; it left Hull on June 11, 1806. Almost a century later, on June 18, 1904, the last raft made the same journey, the owner being another famous local figure - J.R. Booth.... The great rafts were engineering structures of note, statically indeterminate without doubt, but sturdy and stable as built with all the skill of Ottawa rivermen, who became famous throughout the continent.

Rafts could not pass over the Chaudière and so had to be dismantled above, the timbers being passed down separately at first, to be re-assembled in the quiet water below the Falls. Hardwood had actually to be carted around the Falls, as much as 20 days being taken to transfer a full raft. It was no wonder, therefore, that during his first visit, in September 1826, Colonel By was approached for aid with this problem. He persuaded the Earl of Dalhousie to grant 2,000 pounds for the dredging of a channel on the south side of the Falls and this made some improvement. It was Ruggles Wright, Philemon's son, who first suggested the possibility of constructing timber slides as a solution to the continuing problem, following a visit he had paid to Sweden and Norway to study Scandinavian methods of handling large timber. The first slide was built in 1829; two more were soon added and competition became keen. They were most successful; rafts had merely to be disarticulated at the head of the Falls, sent down the slide in sections, and re-assembled below.... The slides were splendid engineering structures, themselves solidly build of squared timbers. Remains of the slides are still to be seen....

With the steady development of Bytown a local demand for sawn lumber arose, to meet which two firms established saw mills using water power derived from the use of a small amount of the water flowing over the Chaudière.... In 1851 Ezra Eddy of Vermont rented a small building in Hull and started to make wooden clothes pins, wash boards, bowls and pails, thus starting the great industry which occupies so dominant a place in the local economy today. John R. Booth came to the district shortly after from his home in the eastern townships; he worked first for the Wrights but in 1858 rented a small shop of his own in Ottawa (with Robert Dollar) to manufacture split shingles. So started another great local industry, the development of which has involved so much plant engineering, as the power available at the Chaudière has been harnessed for use....

Thomas McKay's name is an honored one in Ottawa.... A masonry contractor who had earned an enviable reputation in Montreal before the start of the Rideau Canal works, he was entrusted by Colonel By with the masonry work for the great entrance flight of locks, now so familiar a feature of the Ottawa scene.... McKay was a successful as well as a capable contractor, with the result that he made a good profit on his Rideau contracts. Alone of all the major canal contractors, he chose to stay in Bytown, making this district his home for the rest of his life. Some of his money he invested *(in a mill at the Rideau Falls)*. Another use to which he put his profits was to build for himself a stone mansion, using the skilled Scottish masons he had employed on the locks. This great house was located so far from the centre of the settlement that it was called, derisively, McKay's Castle.... *(It was purchased, with 90 acres around it, for the nation in 1868 and became known as Rideau Hall - the residence of the Governor General).*



The Growth of Ottawa

An associated building must be briefly mentioned, even though engineers can claim no share in its design; its construction, however, was at the time an unprecedented feat of 'engineering construction'. This was the original block of Parliament Buildings, started as early as 1859. In 1860, the Prince of Wales made his special journey to the little settlement of Bytown in order to lay the foundation stone. The East and West Blocks of today give a good idea of what the original group of three buildings must have looked like. Destruction of the main building by fire in February 1916 was a national tragedy, but the noble building replacing it after the war years now forms a most fitting centre to the lovely grouping on 'The Hill'....

Buildings are peripheral to engineering; bridges are not, their design being a major branch of civil engineering. The first major civil engineering undertaking in Canada west of Montreal was the construction of a bridge of which every Ottawa engineer may be justly proud, parts of which are still in daily use by heavy traffic, although unknown and unrecognized by all but a few. Reverting again to that busy visit to Hull in 1826 of the Earl of Dalhousie and Colonel By, the two men saw clearly that access from the north to the south bank of the Ottawa River would be an essential preliminary to the start of the Canal works. Another result of their short visit was therefore a decision that the river must be bridged, Colonel By noting that this could readily be done by a series of short bridges linking together the several islands that made the Chaudière Falls of such beauty. His Clerk of Works for the Canal, a Scot named John McTaggart, was therefore sent up from Montreal together with Thomas McKay, with instructions to get the bridge started; they arrived in Hull early in October, 1826. Undaunted by all the tales he had heard of the Canadian winter, McTaggart decided to build the first stone arch immediately; McKay loyally supported him, as his master mason. So started Canada's first winter construction job, a dry-stone arch with a span of 57 feet being completed by February, work proceeding through what must have been a particularly cold winter. McTaggart has left a graphic account, noting that he froze one of his hands one morning while shaving in an unheated room. It is the same arch that is still in use as an integral part of the modern Chaudière Bridge, located just north of the gateway to the Hull plant of the Gatineau Power Company but naturally unseen from automobiles; one has to be a humble pedestrian to see clearly this splendid piece of masonry work, still serving after 130 years.

Work on the remaining arches proceeded throughout the early months of 1827; Colonel By himself is credited with the way in which the connection was made across the Big Kettle, where a span of 200 feet had to be bridged. He had a small cannon brought to the edge of the gorge...and a shot was fired with a light cord attached across the rushing waters. This was used to pull successively heavy ropes over, until finally it was possible to haul across strong 'iron cables' obtained for the purpose from the naval stores at Kingston.

With this connection made, cables were strung from which was supported a remarkable 200-foot span wooden truss.... The bridge was opened for use in 1827. It provided a 30-foot roadway and is said to have cost only 2,500 pounds. Appropriately named the Union Bridge, it was the first connection between Upper and Lower Canada, and served well throughout the busy canal construction period. But in the spring of 1936 the truss collapsed, fortunately without loss of life.

A ferry service was quickly instituted. Operated by John Perkins, the main ferry boat was one of the early wonders of the Valley for it was one horse power in fact, a horse walking in the boat on a treadle geared to a shaft on which were two paddle wheels. It was not until May 23, 1843, that the foundation stone for a replacement of the ill-fated timber truss was laid, a suspension bridge having been designed by Samuel Keefer under the supervision of H.H. Killaly, Chairman of the Board of Works of Upper and Lower Canada, predecessor of the Federal Department of Public Works. The new span of 243 ft. 6 in. was opened September 17, 1844; it served for many years....

Colonel By was responsible for two other bridges, a small structure initially built of unpeeled logs to span a gully near the north end of the Union Bridge, dubbed 'Pooley's Bridge' by Colonel By since it was constructed by one of his trusted assistants, Lieutenant Pooley, R.E. Much more important, however, was the bridge necessary to span the valley in which the entrance locks of the Canal were to be constructed....it was the first major Canal work to be undertaken under Colonel By's immediate direction by the Royal Sappers and Miners, two companies of which were raised in England in March 1827 especially for service on the Canal. The bridge, known down the years as the 'Sappers' Bridge', was a graceful arched structure occupying part of the site now used for the much larger Confederation Bridge. Built of cut limestone blocks, it was of such massive construction that its eventual demolition in 1912 was an unusually difficult operation....

It was not until the turn of the century that bridge building again became a major engineering activity in Ottawa. It was in 1900 that the still graceful Minto Bridges were built across the Rideau River, and the great Interprovincial Bridge (more kindly named the Royal Alexandra Bridge) was opened February 21, 1901. (Robert Surtess and Guy C. Dunn were the respective engineers.) Both structures were constructed by the Dominion Bridge Company.... Ottawa still has in use one of the first reinforced concrete bridges in Canada, this being the original Hurdman's Bridge built in 1906 by Emil Wahlberg....

It is true that railways had come to Bytown as early as 1854 but it was not until the twentieth century that they really replaced water transport.

It was on Christmas Day 1854 that a small train was pulled into the first railway station of Bytown, located in New Edinburgh *(to the east of the Rideau River)* through Thomas McKay's influence. The train ran on rails improvised from maple scantlings since there were no funds left to purchase iron rails. This was the northern terminal of the Bytown and Prescott Railway Company, for many years the only rail connection that Ottawa had. Until 1855, when the Rideau was bridged, passengers for Ottawa had to be taken across the river by boat after leaving their train. Walter Shanly was the engineer; his letters describing his work on the construction make fascinating reading.... It was not until the close of the century that the effects of the 'railway mania' were seen in Ottawa. These were the years of the Quebec, Montreal and Occidental Railway; the Canada-Atlantic Railway; The Pontiac Pacific Railway Company and others with names almost as pretentious, but their development, construction and eventual incorporation into the C.N.R. and C.P.R. of today, with some disappearing completely, is a tale of this century.

The development of municipal engineering services was, correspondingly if surprisingly, also a feature of the later years of the last century.... It is easy to forget that even when the Parliament Buildings were completed, Ottawa was still a rather grubby little town. The first road in the district had been built by Philemon Wright in 1818, from Hull to what is now Aylmer. It was operated for many years as the Aylmer toll road. Colonel By laid out some of the main streets of what is now the city and built a few other roads to give access to the canal works at Hartwells and Hog's Back. Statute labour was, however, still in use for road maintenance until 1850 so that it is perhaps not surprising that the streets of Bytown had the reputation of being impassable in the spring and fall because of mud, and in the summer on account of dust. It was not until 1862 that the city got permission to issue $40,000 worth of debentures for the drainage and macadamizing of the streets, the first city engineers being appointed in 1866. And it was not until 1895 that the first paving was laid, this being on Sparks Street, between the Canal and Bank Street, specially provided for the holding of a bicycle race. It is therefore not surprising that, in view of the slow development of good streets, Ottawa should have one of the earliest street railway systems in Canada, the Ottawa City Railway Passenger Company being incorporated in 1866. It provided a service of one-man horse-drawn trams until its amalgamation with the newly formed Ottawa Electric Street Railway Company in 1893. The latter had operated its first electric streetcar in June 1891....

With abundant water power so close, it was natural that Ottawa should have been one of the first of Canadian cities to use electricity for lighting, even before it was used for power. It was first used for street lighting November 4, 1884. Pembroke beat its neighbour city by merely a month and thus lays claim to be the first electrically-lit city in Canada. Oil lamps had been used for such public lighting from the earliest days, superceded by gas lamps about 1854....

After the Royal Engineers had found it impossible to find well water on Parliament Hill, they initiated a system of carting water from the Ottawa River. Although some public pumps were provided at strategic points..., water carriers soon came to be an important group in the local economy. So keen did competition between them become that in 1866 they had to be licensed. The first report recommending a proper public water supply was made to the City Council in July 1859 by Thomas C. Keefer. Incredible though it may seem today, the lobbying of the water carriers was so successful that it was not until 1875 that the first City Water Commissioners were actually appointed.... As is so often the case, it took a tragedy - in this case the awful conflagration of 1900 - to bring home fully to the citizens of Ottawa the vital character of their water supply system. The legacy of the water-carriers' opposition to a public water supply certainly contributed to the great loss in that fire which in many ways marked a turning point in the history of the city....

*****

From the August 1947 issue:

The Past: A Chronology of Early Canadian Engineering Activities
by J.G.G. Kerry

Mr. Kerry's paper was one of three presented to a symposium on "The Engineer and the Community" held during the Annual Meeting of the Institute in Toronto on 8 May 1947. The original text had two principal parts: engineering activities per se; *and the early history of the Institute. The extract that follows has been limited to the first of these. Mr. Kerry was one of the few EIC members of his time who were active in the study of the history of Canadian engineering. Within this field, his special interest was in the St. Lawrence Waterway.*

It is no easy task to condense the history of the Engineering Institute of Canada into a limited space.... Yet the story would be incomplete if it did not also include some notice of the earlier achievements of Canadian engineering and the careers of the outstanding men who founded the Institute. Throughout the long history there runs a curious parallel between the periods of political crisis in Canada and the surges of engineering activity within its borders. Each notable political crisis has been followed by bold construction enterprises, and by insistent demands for further service from the engineer.(3)

Canal Building in the Period 1820-1860

The story may be said to have commenced with the war of 1812-1815, when Canada's regard for her neighbours to the south was by no means as friendly as it is today. The war had made it clear to all Canadians how difficult it was to move the men and materials necessary to the defence of Canada to the several localities where they were needed. The termination of the war was therefore followed by many efforts to improve the transportation facilities of the country. These efforts were put forth by private capital and by the British Government. They all were directed towards the creation of an adequate canal system. The Lachine Canal, the Chambly Canal and the Welland Canal were undertaken by chartered companies and finally carried to completion, though not without resort to government assistance. To the members of the Institute today, perhaps the most interesting historical item is that the first President of the Welland Canal was one George Keefer, and that two of his sons worked on the building of that canal during the 1820's. One of these two boys was at long last to become the second President of the Canadian Society of Civil Engineers. A younger brother...was to become the first President of the Society.

The second series of canals, generally known as the military canals, were planned to follow the Ottawa, Rideau and Trent Rivers, and to establish safe transportation between Montreal and a terminal at Penetanguishene. The terminal site at Penetanguishene is still in the ownership of the Crown, in the right of the Province of Ontario.

A brief story of these canal enterprises will be found in the omnibus report published by the Department of Public Works in 1868, after Confederation. This report reviewed all the public works that had been constructed by the United Canadas, and the other colonies. Reference may also be made to a small volume, "Canals of Canada", written by the historian, Dr. W. Kingsford. Dr. Kingsford was himself a civil engineer who had seen service in the canal system. He was a member of the Institute from the date of its organization (in 1887) until his death in 1898. Dr. Kingsford's major work, his "History of Canada", was written in the last decade of his life, whilst he was a member of the Institute.

The City of Ottawa, once called Bytown, is full of memories of the builder of the military canals, Lt. Col. By, R.E., and the contemporary Professional Papers of the Royal Engineers contain interesting articles dealing with construction experiences on those remote undertakings.

The first burst of activity in canal building quieted down early in the 1830's largely because the Canadas were then undergoing a political upheaval which did not terminate until after the acceptance of Lord Durham's report, and the establishment of a new system of government for the colonies. To the members of this Institute probably the most interesting of the Durham papers is a report by Lt. Col. Phillpott, R.E., on the St. Lawrence Canals. To read Col. Phillpott's report today is to find that the hopes and objectives of one hundred years ago were much the same as we dream over ourselves today. Nothing has changed except the magnitude of the works to be built and the size of the vessels to be accommodated. The report may well be called the first official report of the St. Lawrence Deep Waterway.

The new Union government which was formed in 1841 endorsed Col. Phillpott's general programme. Its Board of Public Works, with H.H. Killaly as Chairman and Samuel Keefer as Chief Engineer, went promptly to work on the enterprise....

<u>Railway Building in the "Fifties"</u>

A brief check to all engineering activities came in 1849, when the British Government caused widespread consternation in Montreal by repealing the Corn Laws, thereby depriving Canada of certain lucrative and highly valued privileges in the British market. But hope and energy returned with the completion of the short-lived reciprocity treaty with the United States, and with the resulting upsurge of commercial activity came the building of railroads, the major field of engineering activity during the 1850's. The principal item of construction was the Grand Trunk Railway, and the era came to a temporary halt with the opening of the Victoria Bridge at Montreal in 1860. Sir Casimir Gzowski, who was to become the third President of the Society, and Sir Sandford Fleming were among the more prominent of the engineering leaders of that time.(4)

At the beginning of the same decade the merchants of Montreal determined to create the Montreal Ship Channel, a work which had been begun by the Government in the 1840's and abandoned for fear of silting up. The Montreal Harbour Commission under the leadership of the Hon. John Young, and with T.C. Keefer as engineer, took over the abandoned works and carried them to the completion of their first objective. It was a courageous undertaking, because the Commission had nothing but the revenues of the port to depend on for financing. The present harbour of Montreal stands as a monument to their enterprise and courage. The channel has been almost continuously in process of further deepening since that date. Mr. T.C. Keefer, with the assistance of Mr. Louis Lesage, M.E.I.C., was also busy during the same years building the Montreal Aqueduct and enlarging the water supply system in Montreal.

The "Intercolonial"

About 1860 another halt in engineering activity was experienced because the Canadas were locked in a political stalemate, which ended only when Confederation was achieved in 1867. Another reason for inactivity was that all business in Canada was greatly affected by the battle for supremacy between the Northern and Southern States of the United States of America, which was then in progress. With the advent of peace and the creation of the Dominion of Canada came another outburst of engineering activity. Many efforts had been made to commence the construction of the Intercolonial Railway but all had failed in securing the necessary financial backing. It remained for the Act of Confederation to commit both the Canadian and the British Governments to the enterprise, which was immediately pushed vigorously to completion under the direction of Sir Sandford Fleming, who has published a full record of his stewardship. One fact pleasing to all Canadians is that the British Government was never called upon in any way to implement its guarantees of the funds used in this enterprise.

The new Canadian Government also undertook the enlargement of the canal system, acting upon the advice of a special commission headed by Sir Hugh Allan. This was the enlargement that called forth Mr. T.C. Keefer's jibe that "Canada always builds her canals to plans that are obsolete before construction is commenced". Many a true word is spoken in jest and the present generation of engineers should be on the alert to see to it that history does not repeat itself, for the official plans of today are certainly obsolete.

The Canadian Pacific

An even greater engineering achievement was commenced when in 1871 Sir John A. MacDonald startled the country by undertaking to build a Canadian Pacific Railway main line within ten years from the date of the entry of the Province of British Columbia into Confederation. The job was actually accomplished in fifteen years. How great an undertaking that was at the time may be fairly well judged by anyone who will read Dr. Geo. M. Grant's book "Ocean to Ocean", recording all the happenings on a special journey, made at the request of the Canadian Government in 1872 by Sir Sandford Fleming and Dr. Grant from Halifax to Victoria, to study routes for the proposed railway.

With the completion of the C.P.R. main line there came another lull in engineering activity and for a time many of the Society's younger members had to wend their ways into the United States looking for employment.

<u>Opening Up of The West</u>

Towards the end of the "nineties" the activities of the Canadian Pacific Railway and the Canadian Government, guided by the organizing genius of Sir Clifford Sifton, were creating a new Canadian world west of the Great Lakes, and the call for engineers again became insistent and for activities over an even wider range of technical enterprise. If the reader will look over a group of papers dealing with telegraphs, telephones and electric lighting which were presented to the Society in 1888, he will realize from their phraseology that new ground was then being broken. It may be said with little inaccuracy that the art of utilizing electricity in many different ways reached its first great era of expansion during the 1890 decade. Mr. T.C. Keefer, in his presidential address delivered in January 1888, divided the work of the profession into railways, canals, river improvements, harbours and lighthouses, water supply, sewerage, pavements, tramways, mechanical, wiring and electrical. He noted that the total capital invested in the electric light industry at that time had reached the great sum of two million dollars!

The field of the engineer has in fact been a continuously expanding one, ever since the formation of the Society in 1887, and it is out of the question even to attempt to enumerate all the works of high engineering merit that have been constructed in Canada since that date.

<u>Some outstanding Western Engineering Projects</u>

The *(writer)* may be forgiven if he refers to a few of the projects that have appealed to him personally as being of more than ordinary importance. These works make up a rough chronicle of engineering progress. The order in which they are stated is strictly geographical. The list that follows at least indicates how great are the improvements which have been made in one man's lifetime.

The Lake Buntzen hydro-electric power development in Burrard Inlet was built about 1903 for the B.C. Electric Railway. Subsequently it was enlarged under the direction of G.R.G. Conway, M.E.I.C., and may be regarded as the foundation stone of the present B.C. Power Corporation Limited. This plant was perhaps the first successful example in Canada of the diversion of the flow of a river to a naturally attractive site for power development - a type of development for which British Columbia still offers many opportunities.

The location of the line of the Canadian Northern Railway from Vancouver to the Yellowhead Pass is a work particularly associated with the name of T.H. White, M.E.I.C. This is a masterly development of a railway route across British Columbia that was first reported upon by two young Englishmen travelling on an independent ventuer in 1863, prompted by Imperial vision. The route was subsequently studied and approved by Sir Sandford Fleming. It was later rejected by the Canadian Pacific Railway Company's construction authorities, and finally adopted by Messrs. MacKenzie and Mann for their trans-continental connection in the first decade of this century.

About the same time the spiral tunnels in the Kicking Horse Pass of the Canadian Pacific railway were built, the construction of which did much to reduce the cost of handling the eastbound traffic of the railway across the Rocky Mountain divide. The plans for this grade reduction were worked out by Mr. *John Callaghan*, then a member of the Construction Department of the Canadian Pacific Railway, and the details of the layout attracted widespread engineering comment.(5)

The irrigation system built by the Canadian Pacific Railway in the Province of Alberta was built about 1912 under the direction of J.S. Dennis, Past President, and it included the Bassano Dam across the Bow River, a notable example of dam construction on a questionable foundation. It is realized today that the full development of the possibilities of the Prairie Provinces in the future depends on the application of Mr. Dennis' principles to much wider areas.

The natural gas supply system to Calgary was built by Dr. Eugene Coste about 1912, and was the first full-scale demonstration of the underground riches of the Prairie Provinces. Dr. Coste was not a member of the Institute but was closely associated with his brother Louis Coste who was very active in Society affairs.

The Winnipeg Aqueduct was built in 1913-1918 under the direction of W.G. Chace, M.E.I.C., with J.H. Fuertes, M.Am.Soc.C.E., as Consulting Engineer. This aqueduct, about 85 miles long, carries water by gravity from Shoal Lake (Lake of the Woods) to a supply reservoir for the City of Winnipeg. Its dimensions vary with the natural slope of the prairie over which it was built. It relieved a quite severe shortage of water supply in Winnipeg and the surrounding municipalities. This enterprise was first discussed when Mr. Ruttan, Past President, was City Engineer of Winnipeg.

The construction of the Canadian Pacific Railway's main line north of the Great Lakes was completed in 1885. The most unapproachable section of this work, extending from Mattawa to the Missinabie River, was in charge of W.A. Ramsey, M.E.I.C., as Chief Engineer. Over the uncompleted line moved the Canadian forces that crushed the Riel rebellion in 1885. This work had no outstanding features, its difficulties arising from its remoteness and the severity of the winters along the height of land between the Great Lakes and Hudson Bay. In spite of these difficulties it was completed in advance of the date of the laying of the last rail on the main line across British Columbia. It remains a notable example of well-planned construction management.

Outstanding Projects in Eastern Canada

The Hydro-Electric Power Supply System in Ontario may be said to have originated when the Canadian Niagara Power Company started to build its plant on the Canadian side of the Niagara River about the year 1900, under the local superintendence of C.B. Smith, M.E.I.C. Independent developments by the Ontario Power Company and by the Toronto and Niagara Power Company followed somewhat quickly. Mr. Smith became Chairman of the first Hydro-Electric Power Commission of Ontario, which carried out an extensive series of water power surveys over the settled portions of the Province. This Commission outlined general plans of development that have been followed by the second and presently existing commission of which Mr. Smith was the first Chief Engineer. The Chippawa power development on the Niagara River, and the transmission lines connecting with hydro-electric development in the Province of Quebec, are outstanding features of the present system. Dr. F.A. Gaby, Past President, as Chief Engineer, and H.G. Acres, M.E.I.C., as hydraulic engineer, had charge of many notable pieces of construction for the Commission.

The hydro-electric development of the Ottawa Electric Light Company and associated companies at the Chaudière Falls of the Ottawa River was one of the pioneer electric developments in Canada. Few sites have provided more ice troubles than did this one before the present dam was built across the head of the Chaudière Falls. The profession learned much from the experiences of the operation of these early plants in the 1890's. A. Dion, M.E.I.C., as manager of the company, and John Murphy, M.E.I.C., as superintendent were particularly active in combatting its difficulties.

The development of the copper-nickel industry around Sudbury has had a wide influence on Canadian development. In 1885 it was generally known in the pioneer settlement of Sudbury that extensive areas were being taken up in that neighbourhood for their copper producing possibilities. Yet no work was in progress and the word nickel was never heard. By the end of 1887 Sudbury was well on its way to becoming a town of importance, and the growth of its industry has proceeded almost without check ever since. The ore in this great basin is a very complex one, and many metallurgical problems called for solution before the nickel industry attained the position of prominence and influence to the engineer that it now holds. The names of C.V. Corless, M.E.I.C., and his associates in the Mond Nickel Company are perhaps as well known to Canadian engineers as any of those connecxted with this development.

The work of the Montreal Flood Commission under the guidance of Mr. T.C. Keefer and Mr. John Kennedy deserves a place in any records of Canadian engineering.... It was the first truly scientific attack to be made on the ice problems of Canada and this was carried out in the 1880's. Montreal has been free from flood troubles since the Commission completed its work. The designs for the centre of Montreal harbour were a development from its studies, and the life-work of Dr. Howard Barnes on the problems of ice formation may be credited to initiative arising out of the work of the Commission.

The Montreal Ship Canal is notable for the great effect that its creation has had on Canadian trade, and for the courage, enterprise and skill of the men who undertook the first deepening of this channel, the Hon. John Young and Mr. T.C. Keefer. A very high quality of engineering work, both mechanical and civil, marked the years of development under the direction of Sir John Kennedy, Past President. The great dredging fleet that deepened that channel to 27 1/2 feet by 1887 was very largely the creation of Sir John's mechanical genius.

The completion of the Quebec Bridge after the great disaster of 1907, and the invention of the K-truss, were triumphs of Canadian engineering which stand to the credit of Mr. Phelps Johnson, Past President of the Institute, and of his associates in the *St. Lawrence Bridge Company.*(5)

Many notable engineering works have been planned for the Maritime Provinces, but for economic reasons no one of these great undertakings has reached the construction stage. Most of the structures existing are not unusual in engineering construction, but in building harbours and bridges in the turbulent waters of the Bay of Fundy the engineer has had to overcome unique tidal conditions in a climate which is by no means friendly. The pioneer work of Mr. Martin Murphy, Past President, is entitled to high regard by all who appreciate the overcoming of special difficulties under very definite needs for economy of cost.

*****

From the January/February 1971 issue:

William R. Casey: The Forgotten Engineer
by John Beswarick Thompson

It has been noted that, in Britain, there has been a tendency towards unanimity in the selection of engineers for immortalization.(6) There is also some evidence of this same tendency in Canada with regard to those engineers active during the 19th century, as noted in this next extract. While Casey himself may not qualify for immortalization, the object of the Thompson paper is worthy of emulation in support of other candidates for it.

Time has dealt kindly with the builders of Canada's early railways. The names of Keefer, Gzowski, Shanly and Fleming did not die after the men but are remembered within the engineering profession and by many ordinary Canadians. Yet the civil engineer who supervised the construction of Canada's first public railway, acted as a consultant in the planning of our second completed line and was once honored by the Governor of British North America, has been all but forgotten.

His name was William R. Casey. Born in New York in 1808, he began his career in the early 1830's as a sub-assistant engineer in the construction of the Philadelphia, Germantown & Norristown Railroad. He later moved in the same capacity to the Croton Water-works project in New York and then served as assistant engineer on the Long Island Railway. Casey first came to Canada in the spring of 1834, having been appointed assistant engineer supervising the construction of the Chambly Canal near Montreal.

In November 1834 the Champlain and St. Lawrence Railroad, promoted to link St. Johns on the Richelieu with Laprairie on the St. Lawrence, was formally organized and the fledgling company began casting about for suitable personnel. At about the same time work on the Chambly Canal ceased for the winter and Casey became free to apply for a position on the railway. Having already worked for two American railroads, his credentials were impeccable. Accordingly, at the age of only twenty-six, he was appointed chief engineer of Canada's first railway. It was no mean appointment, for contrary to American practice, the company did not intend to hire a contractor to build the line but planned to complete it alone using day-labor. W.R. Casey was thus in full charge of construction.

Casey began his work immediately. Within the month he and a surveyor had produced a map and section of the line. He spent the winter in Montreal "occupied in giving the information and specifications necessary to enable the Committee to contract, without loss of time, for the timber, iron and materials." In May 1835 the staking-out of the line was started; one month later the grading of the road was begun. By November, Casey was able to announce "the completion of the fencing, graduation *(sic)*, masonary, bridges, the large wharf at Laprairie and the frames of the station houses." All this had been accomplished, he proudly reported, "in a degree of harmony...seldom witnessed on public works." The prevailing *esprit de corps* was due in no small way, according to the directors of the company, to Casey's "tact and attention." Certainly in a period of increasingly bitter French-English relations, Casey's attitude towards his French-speaking workmen was refreshing. Of them he wrote:

> The Canadians formed by far the greater portion of the laborers and maintained their character for behaving with a degree of order and good nature, when working together in numbers, unequalled by any other people.

In the winter of 1836 Casey returned home to New York, stopping enroute at Troy where he purchased four passenger cars for the company. He undertook a similar assignment the following winter when he travelled to Philadelphia to select a second locomotive for the railway. In both cases his judgement proved sound. The cars were used for many years on the line; the locomotive, the Jason C. Pierce, endured until the 1880's.

During the spring of 1836 work began on the final stage of construction, the laying of the track and superstructure. Casey used the American method of construction, known as the 'cheap principle', which relied on the extensive use of wood and half-inch thick iron strap rails. Such a line was admittedly less substantial than the British type which was laid with solid iron rail; however, up to 1848, when the last of Casey's original work was replaced, no serious accidents had occurred on the railway due to track failure. At least part of the credit for this record of safety must be given to the competence of the engineer-in-charge.

Finally, on 21 July 1836 the Champlain and St. Lawrence was officially opened by the Governor of British North America. Casey's work elicited praise from the dignitaries who travelled along the line on the first run. One such observer wrote:

> Certainly too much praise cannot be bestowed upon the conductors for the neat, orderly, and first rate manner in which the whole has been completed. To be sure, the ground offered every advantage, but we in Canada are so accustomed to see things done ill, that a work well done is a miracle.

To mark the inauguration of service on Canada's first public railway, elaborate ceremonies were held at its eastern terminus of St. Johns. Among those honored was William Casey. The directors praised his work; the men presented him with a gold medal in appreciation of his "gentlemanly conduct towards them." But the greatest of tributes was paid him by the Governor himself. He proposed a toast to Mr. Casey, "whose abilities had been extolled by his employers and whose conduct had been approved by those under his control."

Because there were no other railways about to be built in the country following the completion of the Champlain and St. Lawrence, Casey returned to New York. He paid occasional visits north during the next few years making "numerous surveys...in various parts of Upper and Lower Canada," but it was not until 1846 that he had the opportunity of returning to Canada to work on a railway. In that year, the newly chartered Montreal and Lachine Railway invited Casey, whose reputation had remained high, to plan their line. While at work on the project that summer in Montreal, he fell ill with tuberculosis. Tragically, on the sixth of August he died. He was only thirty-eight.

Ironically, Casey's death occurred on the eve of the first Canadian railway boom. With his experience there is little doubt that his services would have been sought after by other railways. With his reputation there is a great likelihood that he, like other engineers of that era, would still be remembered today. Instead, his remains lie unmarked somewhere on the mountainside of Montreal, and his name has been forgotten.

*****

From the October 1920 issue:

The Development of the Steam Engine in the Maritime Provinces of Canada
by D.W. Robb

This paper is important since it describes an aspect of 19th century mechanical engineering activity in Canada that is often neglected, in part because of subsequent changes in the technology of prime movers, in part because most of the companies involved were dissolved or became parts of others with connections to Central Canada or the United States, and in part because of its tenuous connections to the building of canals and railways.(7)

Although Nova Scotia, New Brunswick and Prince Edward Island, the Maritime Provinces of Canada, are more widely known for the extent and importance of their fisheries, lumbering, mining and some departments of agriculture, particularly apples, potatoes, etc. than for mechanical and engineering achievement, it is interesting to find that in the early development of steam engines for steamers, locomotives, and later in connection with electrical apparatus, a department of engineering which has contributed more towards the rapid progress of the world during the nineteenth century than any other, the little provinces by the sea were among the first on this side of the Atlantic.

When we remember that the first practical steam engines were built by Watt from 1775 to 1800 and that we are only now celebrating the centenary of Stephenson who started the steam locomotive on its triumphant career, it may surprise many of us to find that, as early as the years 1844-48 and 1854, John Waring and John Smith, pioneer engineers of St. John, N.B., designed and built marine engines for steamers running on the St. John River. Stationary engines were built by Fleming & Humbert at St. John, N.B., as early as 1838, and locomotives were built by Mr. Fleming before 1860. One of Mr. Fleming's locomotives hauled a train for the late King Edward, then Prince of Wales, when he visited Canada in 1860.

It may be interesting to give a few particulars in regard to the steamers and engines referred to above. I am indebted to Captain R. Retallick of St. John, who has sent me, through Geo. H. Waring, grandson of John Waring one of the pioneer engine builders referred to above, the following particulars:

The steamer <u>Reindeer</u>, for service on the St. John River, was built in 1844. Her engines were compound, the high pressure cylinder being horizontal with Stephenson link motion and the low pressure cylinder oscillating. Captain Retallick states that this was the first compound engine that was run successfully, (probably he means for marine service), but it must have been among the first compound engines built for any purpose. This engine was designed by Tippitts and Waring - built by John Smith at St. John, N.B., and must have been of good design and construction as it was transferred to the steamer Antelope, also a river boat, in 1861 and later installed in the steamer Admiral, which was broken up in the year 1915, so that this engine passed the scriptural 'three score and ten'.

The steamer John Waring was built in 1848 at Woodstock, N.B., by Mr. McConnel. The engines were built by John Waring and had two high pressure cylinders. The boat was a side wheeler as the water is very shallow at Woodstock. The John Waring was launched under steam and came direct from Woodstock to Indiantown, just above the reversing falls at St. John, about 140 miles. She was considered very fast.

The next steamer, Captain Retallick states, was the Anna Augusta built at Fredericton. The engine was a horizontal low pressure, or single cylinder engine, placed on one side of the boat with the boiler on the opposite side and was built by Fleming & Humbert of St. John. She was a side wheeler also.

One of the earliest steamers was the St. John built at East St. John. She was a side wheeler. The engine was built by John Smith. Captain Retallick says it, (the reciprocating part of the engine), looked like a saw mill gate or sash moving up and down. This boat was launched under steam and managed to paddle around into St. John Harbour under her own power, but the hull was so full aft, that she would not steer. Later, after a new stern was added, making her about 24 feet longer, she worked satisfactorily.

George Fleming of Dysart, Scotland, who served his apprenticeship at Dunfermline, grandfather of the present owners of the Phoenix Foundry and Locomotive Works, established at St. John in 1835, and built quite large marine engines for service on the St. John River, Bay of Fundy, and later for the Prince Edward Island service - two of these boats, the Rothesay and the David Weston for river service were famed all over Canada for their speed. The old records of the company show that Mr. Fleming supplied an engine to Brazilian Ansley in 1838, price 250 pounds, and in 1840 an engine and malt mill for 225 pounds and an engine for George Younger, price 180 pounds. The Flemings are said to have built the first steam fog whistle used in any part of the world, which was designed by a St. John man, and was placed on Partridge Island, St. John Harbor.

In the early sixties and seventies, a number of well known engineering concerns in the Maritime Provinces built stationary steam engines for the many large saw mills in New Brunswick and Nova Scotia, as well as for factories, mines and various other purposes. Among the most prominent of these may be mentioned: Geo. Fleming & Sons, John Smith, Harris & Allen and Allen Brothers of St. John; the Pictou Foundry, established by Mr. Davies Sr. in 1854, who came from the old country as master mechanic of the General Mining Association; I. Matheson, formerly located at

Chatham, N.B., and later at New Glasgow, and his son W.G. Matheson; the Truro Foundry and Machine Company; the Burrell Johnson Iron Works of Yarmouth, N.S., which built tug boats and small steamers and marine engines of considerable size, waterworks engines etc.; the Montgomery Iron Works at Halifax, and Moir Symonds. The Montgomery company built a few locomotives which were used on the Intercolonial Railway.

From 1885 to 1890 the use of electric power for lighting, tramways and other purposes began to develop extensively in the United States and to some extent in Canada. Among the first to foresee and take advantage of the increasing demand for improved high speed engines, suitable for driving electric dynamos direct from the engine shaft, was the Robb Engineering Company of Amherst, N.S. This concern, working in collaboration with the General Electric Company, Westinghouse Company and other manufacturers of electrical apparatus, succeeded in producing combined steam engines and electric machines in compact form, adapted to the various services for which electricity was required. The first of these engines was designed and built by the Robb Engineering Company...in 1890-91 under the direction of E.J. Armstrong, who was a pupil of the late Professor John E. Sweet of Syracuse, New York, one of the best

ROBB-ARMSTRONG ENGINES

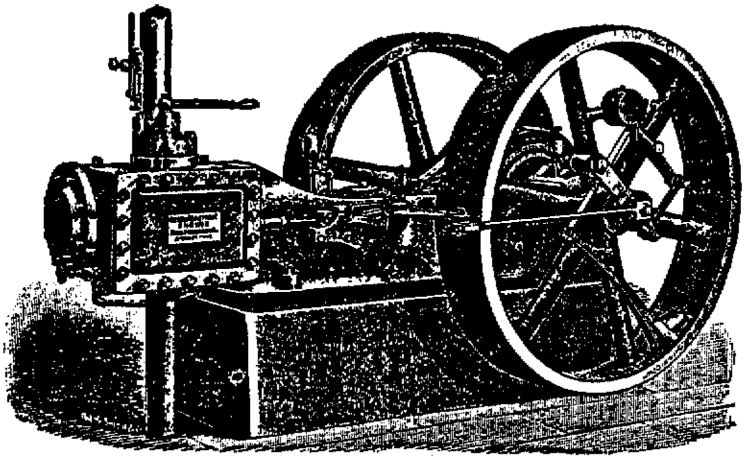
Correct Design, Best Materials, High Grade Work.

SUITABLE FOR ALL PURPOSES. **ALL SIZES UP TO 300 H. P.**

Heating Apparatus.

We are prepared to supply apparatus for heating by Hot Air, Hot Water, or Steam.

Canadian agents for the Fuller & Warren System of Heating and Ventilating for Schools.



General Machinery,

including Rotary Mills, Pulp Mill Machinery, Planers, Band Saws, Shafting, Water Wheels, etc.

Special attention paid to job work and repairing of all kinds of machinery. Charges moderate.

THE MONARCH ECONOMIC BOILER.

REQUIRES NO BRICKWORK. ***GIVES HIGHEST ECONOMY.***

ROBB ENGINEERING CO. LTD., AMHERST, N. S.

Illustration from "The Robbs of Amherst" - see Reference (7) known builders and designers of high speed engines and a great educationist in mechanical engineering.

Mr. Armstrong was able, during the few months he spent at Amherst, through his thorough knowledge of the inter-changeable system used in building high speed engines and his natural ability as a draftsman and shop instructor, to organize a department of the Robb works so that they were able to build, with Maritime Province boys, engines for electric service which were equal to the best produced in the United States or elsewhere. He also enabled this Canadian shop to develop its own steam engineering and drafting departments in which engines were designed and supplied for electric work, not only throughout Canada, but, being among the first in this field, was able to furnish engines of this type to Great Britain, Spain, Australia, India, South America, British Guiana and several West Indian Islands. The exceptional compliment was paid to these works of receiving an order for a compound electric engine for use and educational purposes in the Manchester Technical School at Manchester, England.

The steam turbine has, to a considerable extent, supplanted the reciprocating steam engine for large electric units where steam furnishes the motive power. Oil and gas engines are making considerable headway for the smaller units and to some extent for marine use.

The tremendous development of water powers in Canada has also restricted the use of steam engines for electric production, but as yet the marine field is to a very large extent held by the steam engine. In passing it will no doubt be of interest to mention that the triple expansion engines to be installed in Nova Scotia's two largest ships, 8100 tons each, were built at Amherst. One of these ships, the <u>Canadian Mariner</u>, was launched from the Halifax Shipyards on 4th of September *(1920)* and the other is well advanced in construction.

There is no doubt that steam engines will continue to be built and used for ship propulsion for some time to come, or until the rapid changes constantly taking place in engineering construction bring forth something better or more efficient or economical.

*****

Also from the October 1920 issue:

Reminiscences: Pioneer Life in the West
by H.J. Cambie

This extract is more autobiographical than technical and deals mainly with the period from 1876 to 1886. Details of Mr. Cambie's early life have been omitted, as have most of the reminiscences of Eastern Canada and the contacts with non-engineering people and situations mentioned in the original paper - which, interestingly, was published during the month of his 84th birthday. Shortly before his long life ended in 1928, the EIC erected a tablet in the Canadian Pacific Railway terminal in Vancouver in recognition of Cambie's work on the location of the railway across British Columbia and his supervision of its construction through the Fraser canyons. This tablet was re-erected a few years ago when the terminal building was refurbished.

My experiences for the next twenty years *(1853-73)* were just like those of any other engineer employed continuously on explorations, surveys and construction....Coming to the mountains of British Columbia in 1874, I had a few experiences out of the common. In 1875 I was instructed, by Mr. Marcus Smith (my chief) to make an exploration and survey for a line to Bute Inlet, by way of the Homathco River, passing through the country of the Chilcotin Indians....

During the years 1876-78 explorations and surveys were made continuously under my charge through all the passes in the Cascade Mountains, from the Pacific Coast towards the Yellow Head Pass, and the route from Burrard Inlet, via the Fraser and Thompson Rivers, was selected as the most favourable.

Exploring the Peace River District

But in 1879, the Minister of Railways, Sir Charles Tupper, and the Chief Engineer, Sir Sandford Fleming, determined to put off construction for a year, for various reasons, and in the meantime make as complete an exploration of the Peace River country as was possible in one season, examining it from various points of view - as to the obstacles in the way of railway construction, as to its suitability for settlement and agricultural pursuits, and as to its mineral possibilities from a geological standpoint, before actually letting contracts for the work of construction on another route, and so fixing the location irrevocably.

In carrying out this idea, I had the honour of leading into that country, a party of most distinguished men: Rev. D.M. Gordon, who was till lately Principal of Queen's University at Kingston, the late Dr. G.M. Dawson, assistant director of the Geological Survey, with Mr. McConnell, his assistant, who was afterwards director of the Geological Survey, also Mr. H.A.F. Macleod, who with myself, was to report more particularly of the engineering features of the ground we traversed.

We came from Ottawa to San Francisco by rail, thence to Victoria by boat. There I chartered the Princess Louise, a steamer belonging to the Hudson's Bay Company, which took us to Port Simpson, the natural outlet for a line from the Skeena River Valley, and one of the finest harbours on the Pacific Coast of Canada. Thence we proceeded across the country, by canoes on rivers and lakes, and on foot over mountain trails, etc. to Fort Macleod, on Crooked River, a small tributary of the Peace.

At Fort Macleod we patched up an abandoned boat of the Hudson's Bay Company, caulked the seams with leaves etc. and drifted down the Crooked River, the Parsnip and the Peace to Rocky Mountain Portage - about one hundred and fifty miles - one man bailing all the time. At the other end of the portage (opposite Hudson Hope) we made a raft and drifted on it nearly one hundred and fifty miles further, to Fort Dunvegan....

From Fort Dunvegan we scattered - Mr. Macleod and I hired the few horses (six) which the Hudson's Bay Company had to carry our provisions, and travelled South about fifty miles to, approximately, the place now known as Grande Prairie, all the way through excellent land. There we parted, he going West and I going East.

I crossed Smoke River and its branches to Sturgeon Lake where there was a band of Cree Indians, and then to Lesser Slave Lake, passing through a country, all of which was fit for cultivation and settlement if the climate should not prove too rigorous.

From Lesser Slave Lake we returned to Dunvegan by the regular Hudson's Bay trail, crossing the Peace at what is now known as the town of Peace River - but there was not even a single inhabitant there at that time.

We reached Lesser Slave Lake on a July evening, and in front of the Fort, at the head of the Lake, there is a large flat, flooded at times, on which grew course grass - on this were several mowing machines at work, also horse rakes, and men stacking the hay, as well as some milch cows grazing, and all this, seen in the light of the setting sun, seemed to me, after some months in the wilds, to be one of the most peaceful and beautiful scenes I had ever witnessed.

The country from Peace River Crossing to Dunvegan was over a plateau of indefinite extent, at an elevation of several hundred feet above the Peace River, and all of it fit for settlement.

All the way from Lesser Slave Lake to Dunvegan, a distance of perhaps one hundred and twenty miles, we did not meet a human being at that time, nor in all that country, except about three Indian families and the Crees at Sturgeon Lake.

All the members of our party assembled again at Dunvegan early in September and made a joint report, which was wired to Ottawa from Battleford, the nearest telegraph station. And we then each took up our journey for home, breaking up the best informed, most congenial and happiest party with which it was ever my good fortune to be associated....

In 1917, after a lapse of just thirty-eight years, it was my privilege to visit this country again, and to travel by railway in a sleeping car from Edmonton to Peace River and shortly afterwards to travel by motor from there to Dunvegan. In all this motor trip from Peace River Crossing to Dunvegan and on to Spirit River (formerly known as Ghost Creek) there were good country roads, for we made ninety miles in about seven hours, and all the way was through, or in sight of, wheat fields - and the houses were sufficiently close to each other to support schools at reasonable distances....

In 1879, I returned to British Columbia by the Pine River Pass, with a pack train of about thirty animals. We had been delayed by various causes and only reached its summit October 1st. There we were caught by a fall of snow, which ended the feed for our poor animals, with still two hundred miles to go, except for one night on a prairie covered with lupins, which stood above the snow.

On reaching the Nechaco River, we obtained a boat and taking most of our baggage descended it and the Fraser River for over a hundred miles with ice forming along the shores, and ran all the rapids without a pilot, except the Fort George Canyon, till we reached civilization at Quesnel Mouth.

Building the Canadian Pacific Railway

At the end of 1879 the Government at Ottawa decided to adopt, as the route for the Canadian Pacific Railway, a line through the Yellow Head Pass and via the Thompson and Fraser Rivers to Port Moody on Burrard Inlet, and at once called for tenders for the construction of that portion, extending from Emory's Bar, five miles west of Yale (the head of river navigation) to Savonas Ferry, at the outlet of Kamloops Lake (the beginning of inland navigation), a distance of one hundred and twenty-eight miles.

This was divided into four contracts, and I, having been identified with the canyons of the Fraser, which had been pronounced by some prominent engineers as impracticable for a railway, was given charge of Contract 60, which embraced these canyons.

The work was allotted to the lowest tenders, which were all

Canadians, but before construction was actually commenced, they were severally bought out by Andrew Onderdonk, a young man from the Unites States only about thirty years of age, a clever engineer, of excellent organizing ability, who had splendid financial backing.

We, the engineering staff, came from Ottawa to British Columbia via the Union and Central Pacific Railway and by boat to Victoria, which was the only available route at the time.

As soon as snow had gone, at the end of April, we proceeded to Yale to locate the line and lay out the work.

Up to that time, we had been given as our standard, a maximum of four degree curves and one per cent grades, except in one or two special cases, where we might be allowed to consider something sharper and report on them.

We had located about two miles, with the above as a standard, when I received a telegram from the chief engineer to "locate the cheapest possible line, with workable curves and grades."

I stopped the survey at once and with Mr. T.H. White, my principal assistant,...spent a day examining the ground at sundry critical points, and adopted eight degree curves as our maximum, with one per cent grades. The conformation of the ground was such that steepening of grades could not reduce the work much, but sharpening of curves could do wonders in avoiding tunnels and other expensive works, and we considered eight degree curves the sharpest we were then justified in adopting for a transcontinental line.

In order to reduce the amount of excavation, in many places we built the line along the face of bluffs where there was good foundation for walls, but no building stone available till it should come by train, so trestles were built with steps cut in the rock for the posts. We built many such, with the outer post thirty or more feet in height and the inner one very short, or perhaps without a post at all, but the end of the cap resting directly on the rock.

There was a special design made for each bent of every trestle and, though some of them were not replaced for ten ot twelve years afterwards, not one of them ever failed or caused an accident....

Contract 60 was completed early in 1884, and my work for the Government came to an end. I at once, however, entered the service of the Canadian Pacific Railway Company and took charge of construction from Savona, eastward.

I had then been ten years in the service of the Government, in British Columbia, on the explorations and surveys for the selection of a route, and on construction, and had the pleasantest relations with my Chiefs, Hon. Alexander Mackenzie, Minister of Railways till

1878...my dear old Chief, and life long friend Sir Sandford Fleming, and later my dear friend Sir Collingwood Schreiber.

The track from the West was connected with that from the East at Craigellachie, three hundred and fifty miles from Vancouver, on November 7th, 1885, but it was not opened for traffic until July 1886.

At the driving of the last spike, by Sir Donald A. Smith, there were present, as the British Columbia contingent: Marcus Smith, representing the Dominion Governmment; M.J. Haney, representing Onderdonk; and Major Rogers and myself, representing the Company's work Eastward through British Columbia.

Early in 1886, the Railway Company decided to extend the line from Port Moody, the Government terminus, along the shores of Burrard Inlet to Coal Harbour, where the City of Vancouver was afterwards laid out and built, and this extension came under my charge, as engineer of the Pacific Division....

I continued as engineer of the Pacific Division of the C.P.R. from 1886 to 1903, and superintended the replacement of the wooden bridges by steel and masonry - and most of the trestles by fills with walls where necessary, and have finally retired from the service in 1920, having been over sixty-seven and a half years at work...

*****

From the August 1954 issue:

Canadian Hydro Electric Developments on the Niagara River
by Dr. R.L. Hearn

This paper was presented before the 68th Annual Meeting of the EIC at Quebec City. It sketched the early history of power developments on the Canadian side of the Niagara River and brought the story up 1954 and the design of the Sir Adam Beck-Niagara Generating Station No. 2. It also covered the early discussions of the public ownership of power generation facilities that led to the creation of the Ontario Hydro Electric Power Commission. The extract that follows stops the story at 1950 when the revised Boundary Waters Treaty, which laid the groundwork for Beck-Niagara No. 2, was passed. The diagram that appears at the bottom of page 30 helps locate the Canadian facilities on the Niagara River.

The history of the Niagara River and Falls dates back some 200,000 years to the ice age, when glaciers thickly covered the Great Lakes area. As the glaciers melted and retreated, vast lakes and drainage systems developed which were the forerunners of the present-day geography of Southern Ontario.

The Falls themselves and, in fact, the upper Great Lakes, owe their existence to the hard limestone strata which forms the Niagara river bed and the crestline of the Falls. This hard rock formation has prevented Lake Erie from draining completely into Lake Ontario.

Following the scoring and gouging of the earth's crust, the glaciers melted. A lake was formed in the Erie basin, which found an outlet over the Falls to Lake Ontario. Most of the Upper lakes water flowed down the Ottawa River, which extended far up the St. Lawrence valley.

When the level of this body of weater fell below the divide of the Ottawa, large volumes of water began to flow over the flats of what are known as the St. Clair and Detroit Rivers. So today, the Niagara is 'backed' by a large natural headpond, comprising four lakes formed by the glaciers - Superior, Huron, St. Clair and Erie.

Dependability of flow is an extremely important factor in determining the value of a river with respect to the production of hydro-electric power. In this regard, the Niagara River, with its vast storehouse of water to draw on, ranks with the best....

Industrial Progress Hinges on Electricity

In the latter part of the nineteenth century, industry in southern Ontario faced a crisis; where to find a cheap dependable source of power to keep the wheels of industry turning. The timber line was fast receding, and it had become uneconomical to haul wood for steam operated plants. Coal from the United States was too costly for sound operation.

Even the use of localized water-power plants to produce electricity was not entirely satisfactory, since their output was confined to a small radius, and the denuding of the forests meant heavy spring run-offs with consequent low water flows for the rest of the year.

The answer to future progress was the utilization of dependable river flows, such as the Niagara River, to produce electricity and transmit it to the growing manufacturing centres. For more than 60 years, the waters of Niagara have been used to generate the electricity which has been one of the chief factors in the economic strength and growth of Ontario....

International Boundary Waters Treaties

The Boundary Waters Treaty of 1909-1910 was signed between Great Britain and the United States. As it relates to Niagara, this treaty permitted, for power purposes, the permanent daily diversion from the Niagara River above the Falls of 20,000 cubic feet of water per second to the United States, and of 36,000 cubic feet per second to Canada.

During World War II, Ontario Hydro obtained an additional 5,000 c.f.s. of water for power purposes at Niagara Falls through the Long Lac-Ogoki diversions. Additional temporary diversions were obtained through an exchange of letters between Canada and the United States of America in the years 1941, 1944 and 1948.

These temporary diversions amounted to 15,000 c.f.s. - 2,500 c.f.s. of which was available only during the non-navigation season - and enabled the Commission to operate all of the plants on the Canadian side to their maximum capacity....

In order to maintain a proper pool level above the Falls, a submerged weir was built just below Chippawa and above the Rapids, during the years 1942 to 1944. This submerged weir assisted in maitaining the level of the Grass Island Pool, even at times of increased diversion for power purposes. At the same time it increased the flow over the American Falls, thus enhancing the scenic effect considerably.

After the cessation of hostilities, negotiations were entered into by Canada and the United States with a view to revising the 1909 Treaty to permit re-development of power on both the Canadian and American sides of the Niagara River. These negotiations resulted in the signing at Washington on February 27, 1950, of a new treaty known as the Niagara Diversion Treaty.

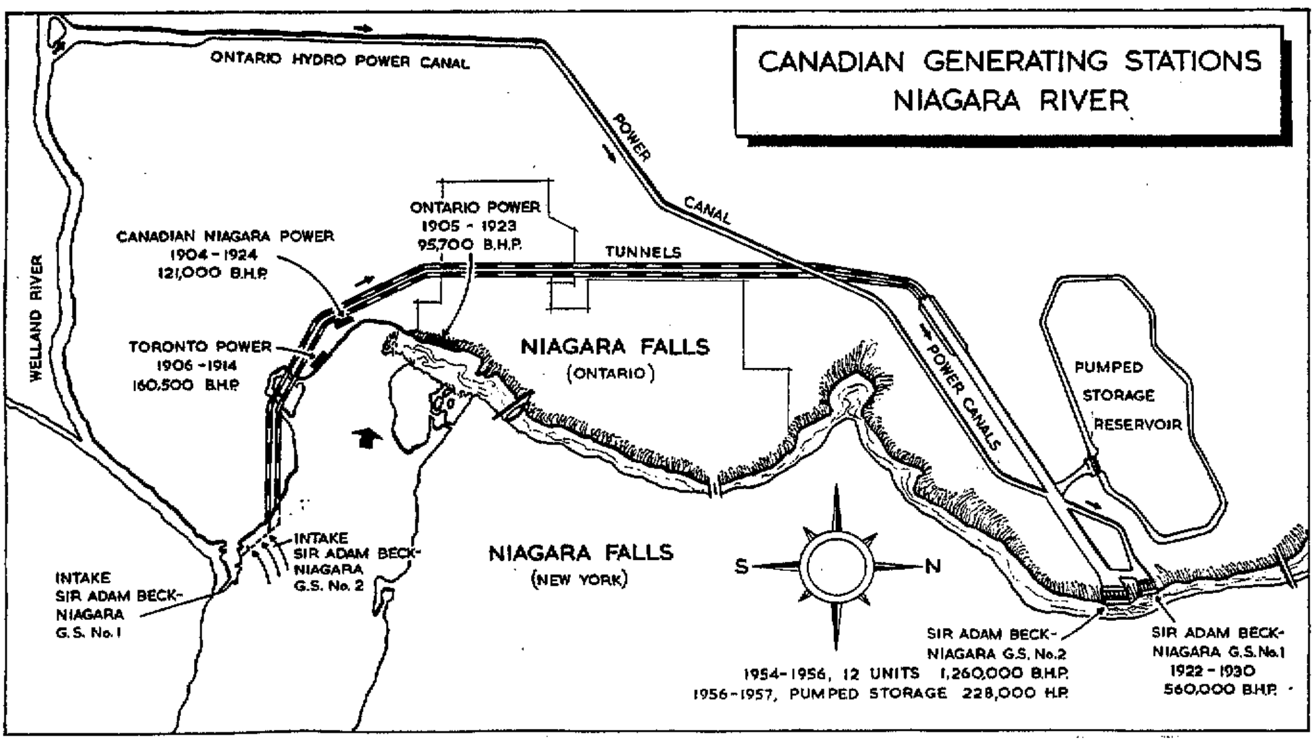
The significant feature of the new treaty was that, instead of a definite amount of water being designated for power as in the 1909 treaty, a definite flow over the Falls was stipulated to preserve and enhance the scenic beauty. The balance after allowance for domestic, sanitation and navigation purposes is allowed to be diverted for power production - 50 per cent to each country - exclusive of the 5,000 Ogoki diversion which belonged entirely to Canada.

When the 1950 Treaty was ratified on October 10, 1950, Ontario Hydro was in a position to start immediately on the redevelopment of the Niagara River with the construction of the Sir Adam Beck Generating Station No.2....

First Diversion of Water for Power Purposes

The first diversion of water for power purposes on the Canadian side was the small plant constructed in 1893 to operate the International Railway Company's electric line from Chippawa to Queenston. This plant was operated under a head of 62 feet, with an ultimate capacity of 3,000 hp. in 2 units. In 1932, on the expiration of the 40-year lease, the railway was dismantled and the plant abandoned.

At the turn of the twentieth century, hydro-electric power development at Niagara Falls on the Canadian side received a tremendous impetus when three large power stations were in the course of construction at the same time, namely, those of the Canadian Niagara Power Company, the Ontario Power Company, and the Electrical Development Company.



Canadian Niagara Power Company

The Canadian Niagara Power Company was the first to begin construction operations in 1901. The plant has an operating head of approximately 135 feet. Between 1904 and 1924 eleven vertical type units were placed in service, with an installed capacity of 121,000 horsepower.

This plant followed the same design as the Adams plant of the Niagara Falls Power Company on the American side. The water is obtained from the Niagara River by means of a gathering weir, and is carried to the water turbines by penstocks at the bottom of the wheel pit. The discharge from the draft tube is taken back to the Niagara River by a long tail-race tunnel.

Ontario Power Company

The Ontario Power Company in 1900 acquired a charter granted by the Dominion Parliament in 1887, and began work in July 1902. The design used by this company for its development showed a radical departure from the two plants mentioned earlier. While water was diverted from the Niagara River by a gathering weir, it was carried underground across country from this point through three pipelines, 6,500 feet long, to the top of the escarpment just below the Canadian Falls and from there down through penstocks to the power house situated on the bank of the river below the Falls.

By this arrangement, The Ontario Power Company was able to obtain an operating head of 180 feet. The present equipment in this plant consists of 15 units - the horizontal type with double runner turbine units. The rated capacity of the plant is 195,700 horsepower. In August 1917, the station was purchased by Ontario Hydro.

The plant is of particular engineering interest, as it was on this development that one of the largest steel conduits, 18 feet in diameter, was installed. The second pipeline was one of the largest oblate reinforced concrete pipes ever constructed in Canada. The third pipeline, put in as an emergency measure during World War I, is one of the largest wood stave lines in the Dominion. This 13-foot diameter wood stave pipe was covered with concrete on the outside, and is still operating. The steel bands of the wood stave pipe are being used for taking the tension, and the concrete on the outside is used for water tightness and stability.

It was for this development that the late R.D. Johnson invented, designed and installed the first Johnson differential surge tank in the world. It was also for this plant that he designed and installed the Johnson differential valve, and designed and built one of Canada's largest reinforced concrete tanks at that time.

The Ontario Power Company plant has an interesting historical background. It was twice flooded with water and ice, caused by ice jams in the Niagara River. The last flooding occurred in January 1938, when the ice below the Falls reached a level some 58 feet above normal at the south end of the plant. It was at that time that the Upper Steel Arch Bridge was destroyed.

Electrical Development Company

The Electrical Development Company plant, later the Toronto Power Development, was built simultaneously with the Canadian Niagara and the Ontario Power Company developments. Work began in 1903 with the installation of the eleventh and final unit in 1914. This plant is the same kind as the Canadian Niagara. It is situated just upstream with an operating head of 137 feet, and has an installed capacity of 160,500 horsepower.

The Electrical Development Company was leased by the Toronto Power Company in 1908, and was opearated by them until acquired by the Ontario Hydro in 1922. Since that date it has been known as the 'Toronto Power' plant. It was from the Toronto Power Company, incidentally, that the city of Toronto first received electricity generated from the waters of the Niagara River.

While Niagara was being harnessed by these three companies, industrialists and leading businessmen in Toronto and Western Ontario were advocating methods whereby this power could be generated and transmitted to the industrial centres in Southern Ontario at economical rates, and thus provide energy for industrial expansion and the improvement in the living conditions of the people.

On February 17. 1903, in the Y.M.C.A. Hall, (Berlin) Kitchener, 67 persons gathered to discuss the idea of public ownership of hydro-electric power. These men included representatives from manufacturers' associations, boards of trade and councils of municipalities.

This was the first meeting, in connection with the power movement, attended by Adam Beck who, at the time, was Mayor of London and a member of the Ontario Legislature, as well as a prominent manufacturer in his own right. From the time he appeared as a supporter of the low-cost power movement, he assumed a position of leadership.

As a direct result of the efforts of these men who led a general movement on behalf of cheaper hydro-electric energy, the Hydro-Electric Power Commission of Ontario was created by a special Act of the Provincial Legislature in 1906.

On May 4, 1908, fourteen municipalities made the first Hydro contract for a total of 26,235 horsepower. Those municipalities were Kitchener, Hespeler, Galt, Preston, Waterloo, New Hamburg, Toronto, London, Guelph, Stratford, St. Thomas, Woodstock, St. Mary's, and Ingersoll....

Queenston Development

In 1914, Ontario Hydro first considered a power development at Niagara Falls that would use the maximum economical head between Lake Erie and Lake Ontario. As a result of these studies construction of the Queenston-Chippawa Development, now known as Sir Adam Beck-Niagara Generating Station No. 1, was started in 1917. The first units were put into operation in 1922 and the tenth unit in 1930. At the time this plant was built, it was the largest hydro-electric development in existence.

The general scheme of development comprises an intake structure at the junction of the Welland and Niagara Rivers at the town of Chippawa. At this point, water is drawn from the Niagara River through the intake, and into the Welland River whose flow was reversed for four miles.

From this point a canal was constructed across country on the west side of the city of Niagara Falls and through the township of Stamford to a point on the Niagara escarpment a mile south of Queenston. The 8 1/2-mile long canal was one of the largest hydraulic power canals when constructed, and in its design presented many interesting hydraulic problems.

The units in the power station vary from 52,500 to 58,000 horsepower, and are of the vertical type. At the time of installation, they were the largest hydraulic generating units ever constructed. A few years later, however, the Niagara Falls Power Company on the American side put in some 70,000 horsepower units. Power generated in the Queenston plant is sent as far west as Windsor and Sarnia, a distance of 240 miles....

On the completion of the Queenston-Chippawa Development, further developments in the Niagara River were not possible with the amount of diversion permitted under the 1909 Treaty. It was not until the 1950 Treaty was ratified *(as mentioned above)* that Ontario Hydro could start on further development on this famous Niagara River.

*****

Notes and References

(1) Andrew H. Wilson, The Engineering Journal, 1918-1987: Some Notable Highlights, EIC History & Archives Working Paper 1/1995, Engineering Institute of Canada, Ottawa, December 1995.

(2) Andrew H. Wilson, The Engineering Journal as a Source for the History of Engineering, EIC History & Archives Working Paper 6/1998, Engineering Institute of Canada, Ottawa, March 1998.

(3) Writing as he did in 1947, Kerry refers to the 'Institute' even when, prior to April 1918, it was still the Canadian Society of Civil Engineers. Yet he occasionally refers (correctly) to the 'Society'. Also, he refers to Past Presidents as having been 'President of the Institute' or, simply, as 'Past President' when they had served in that office of the Society. But, quite correctly, he uses the letters 'M.E.I.C.' to distinguish engineers who were members of the Institute from those who were not.

(4) It should be remembered that Casimir Gzowski was not knighted until 1890, nor Sandford Fleming until 1897. Also, John Kennedy was not knighted until 1915. It should also be noted in this same context of Canadian 'engineer-knights' that the H.J. Cambie extract beginning on page 23 refers to Sir Sandford Fleming prior to 1897, and also to Sir Collingwood Schreiber, who received the KCMG shortly before he died in 1918.

(5) Corrections to the Kerry paper were given in the November 1947 issue of the Engineering Journal, on page 554.

(6) See, for example: "Perceptions of great engineers: fact and fantasy" edited by Denis Smith, The Science Museum, London, 1994.

(7) More on the development of steam engines in Eastern Canada can be found in the essay by Larry McNally, "Jacks of All Trades," in CSME's Commemorative Volume, From Steam to Space.... More on D.W.Robb's company can be found in the article by Andrew H. Wilson, "The Robbs of Amherst," in the November 1997 issue of the CSME Bulletin.

*****

Biographical Notes: The Authors

Robert F. Legget: Was born in Liverpool, England, in 1904, and died in Ottawa at the age of 89. He received bachelor's and master's degrees in civil engineering from the University of Liverpool in 1925 and 1927. After working with a firm of consultants, he came to Canada in 1929, joining the Construction Division of the Power Corporation of Canada and, later, the Canadian Steel Sheet Piling Company of Montreal. From 1936 to 1938 he was a lecturer in civil engineering at Queen's University and, from 1938 to 1947, assistant and associate professor at the University of Toronto. From 1947 *until 1969 he served as the founding Director of the Division of Building Research of the National Research Council in Ottawa. He made many contributions to civil and geological engineering and to building research and was a prolific contributor to the study of the history of engineering in Canada - for all of which he received many honours. He first joined the EIC in 1929, was elected a Member in 1940 and a Fellow in 1965.*

J.G.G. Kerry: *Was born in Montreal in 1867 and was educated at McGill University, from which he graduated in 1886 with a degree in civil engineering. He spent several years on railway surveys in Canada and the United States, returning to Canada to qualify for an MEng degree, also from McGill. He then joined the McGill teaching staff, remaining there until 1907. However, in 1898 also became a partner in a consulting firm. From 1907 until 1932 he was associated with the Temiskaming and Northern Ontario Railway as a consulting engineer, and was also active for many years in the construction and operation of power plants and paper mills. He retired in 1939. Mr. Kerry was particularly interested in the development of the St. Lawrence Waterway and wrote several papers about it, which he read at meetings of the Institute. He joined the 'old' CSCE as a student in the year of its founding, becoming an associate member in 1894 and a full member in 1904. He was elected to Honorary Membership of the Institute in 1952. He died five years later.*

John B. Thompson: *Is the only non-engineer among the the six authors. He recieved a B.A. degree from McGill in 1962 and an M.A. (History) in 1967. He worked first as a teacher at Stanstead College, Quebec, from 1965 until 1969 when he joined the National Historic Sites Service in Ottawa as a staff historian, the position he held at the time his paper was published.*

David W. Robb: *Born in 1856, he was the eldest son of Alexander Robb Jr., who founded what became the Robb Engineering Company Ltd., of Amherst, Nova Scotia. At the age if 16, on his father's retirement because of ill health, David Robb and his younger brother Fred took charge of the running of the business, with David having particular responsibility for the shops. Five years later the brothers assumed full control. The company was incorporated in 1891, when David was 35. Under his leadership the company continued to prosper for another dozen years, by which time steam turbines had replaced the reciprocating engines built by the company in many applications. Robbs' was taken over in 1923 by the Dominion Bridge Company. David Robb was elected a member of the 'old' CSCE in 1894. He died in 1934.*

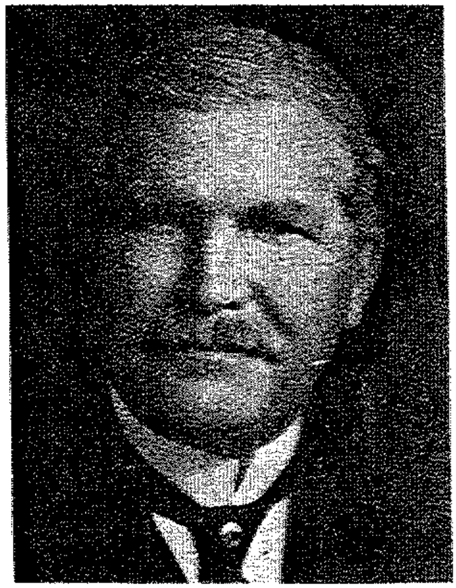
Henry J. Cambie: *Was born in County Tipperary, Ireland, in 1836 and came with his parents to Canada in 1852. His work on railway location, construction and maintenance began that same year, when he entered the office of Walter Shanly. In 1853 he joined C.S. Gzowski and Company for contract work on the Grand Trunk railway,* *west of Toronto. In 1859 he served his time as a land surveyor under Col. J.S. Dennis. From 1863 to 1879 he was employed by Sandford Fleming and others on railway explorations, surveys and construction in Nova Scotia, Quebec and British Columbia. As noted in his paper, from 1880 to 1883 Cambie had charge of Government Contract 60 for the building of the railway through the Fraser canyons. In 1884 he joined C.P.R. for work on construction and maintenance. In 1904 he was appointed special assistant engineer for the C.P.R.. From 1908 to 1920, when he retired, he was chief engineer of the Esquimalt and Nanaimo Railway. Cambie joined the 'old' CSCE in 1888 as a Member.*

Richard L. Hearn: *Died in May 1987, a week after his 97th birthday. Joining Ontario Hydro in 1913 on graduation from the University of Toronto, he headed the design team for the Sir Adam Beck No. 1 Generating Station. Eight years later he left Hydro to join the Waskington Water Power Company in Spokane as assistant chief engineer, returning to Niagara Falls in 1924 as a partner in the consulting firm, the H.G. Acres Company Ltd. In 1930 he joined the Dominion Construction Company and H.F. McLean Ltd., becoming chief engineer in 1934. Hearn returned to Ontario Hydro in 1942, participating in its postwar development, becoming chairman in 1955. A year later he retired to consulting, and was fully retired by 1975. He was involved in the creation of Atomic Energy of Canada Ltd, serving as a director, and in the development of the CANDU nuclear reactor program. Hearn received numerous honours during his lifetime. An Ontario Hydro generating station was named after him.*

The principal source of this biographical material has been the Engineering Journal. The same may be said for the photographs that follow, with the exception of the one of David W. Robb, which came from "The Robbs of Amherst."

*****

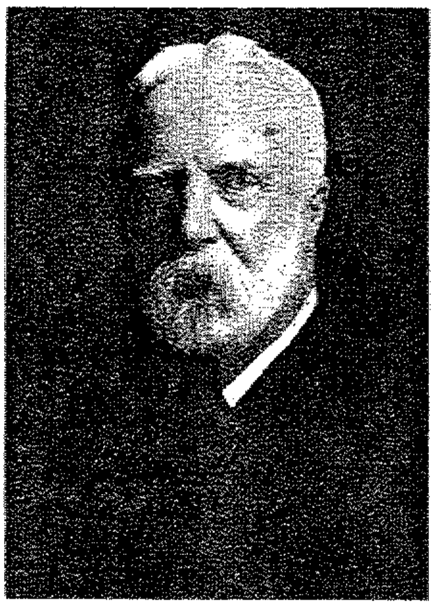
R.F. Legget



J.G.G. Kerry

J.B. Thompson

D.W. Robb



H.J. Cambie

R.L. Hearn