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"The *Canadian Geographic* and the History of Engineering in Canada"

by Andrew H. Wilson
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WORKING PAPER 7/1995

The *Canadian Geographic* and the History of Engineering in Canada

by

Andrew H. Wilson

January 1995

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Abstract

This paper analyses the issues of the Canadian Geographical Journal and its successor, the Canadian Geographic, published between 1966 and 1992 for articles broadly descriptive of engineering in a historical context in order to demonstrate that journals whose principal purpose is to disseminate information on geographical subjects can also be useful sources of information on activities, machinery and techniques associated with the history of engineering and on the museums that exhibit engineering artifacts. The paper then goes on to describe a selection of the activities, machinery and techniques from specific articles on the basis that the articles themselves were of historical interest in engineering terms at the time of publication, became of interest after publication, or are likely to become of interest sometime in the future. It also describes features of some of the museums.

About the Author

Andrew H. Wilson is a graduate mechanical engineer with training in economics. Currently a consultant in research policy and management, he served for almost 30 years in the Public Service of Canada. He is also the founding - as well as the current - Chairman of the History Committee of the Canadian Society for Mechanical Engineering. Parts of this paper were presented by the author at the Fourth CSME History Committee Seminar at McGill University in Montreal in June 1994.

About the Working Paper Series

Author's Note

The ILLUSTRATIONS included with this paper appear together at the end of it. The appropriate numbers have, however, been given in the corresponding items of the text.

The author wishes to thank Ian Darragh, the present editor of the Canadian Geographic, for kind permission to photocopy the originals of the various ILLUSTRATIONS for use in this paper.

Introduction

Sometimes we find interesting information on historical subjects in unexpected places. One of these may be a magazine devoted to geography, and an example of such a magazine is one now called the Canadian Geographic. And if we look further at the historical subjects covered in this particular magazine we see that some of them have a connection with engineering.

On the face of it, history and geography seem like strange bedfellows. History is predominantly concerned with people and societies, with politics and economics, while geography is concerned with the physical characteristics and resources of the earth's surface and crust, and with climate. But if we consider these bedfellows a little further we will realize that the people who appear in history have always been surrounded, and influenced, by geography. They have also moved from one type of surrounding to another. They have explored all of the very different corners of the Planet Earth. They have exploited the resources of its surface and crust, and have changed both. They have not perhaps had quite so much influence on climate although, nowadays, this influence seems to be increasing.

If we add engineering to the mixture we find that it has been influenced by both geography and history and has, in turn, influenced them. Indeed, it has been one of the important people-inspired agents of geographical and historical change.

The Canadian Geographical Society was founded in February 1929, before 'Black Friday' happened. But by the time the Society published the first issue of its Canadian Geographical Journal in May 1930 the Great Depression had begun. This magazine was intended to help stimulate awareness - and the general diffusion - of information about Canada's geography in a 'popular' way, and it has been doing so for nearly 65 years. But its subjects have not always been strictly geographical. Some, indeed, have had strong historical connections and, increasingly in recent years, environmental issues have intruded. Engineering subjects, as we will see in a moment, have also been covered explicitly or implicitly in its articles. The magazine was originally published monthly. By early 1976 it had become a bi-monthly, but with expanded content in each issue. In August 1978 its name was changed to the Canadian Geographic. The Society itself was dubbed 'Royal' in 1957.

In preparing this paper, the issues of this magazine published during the period from January 1966 to December 1992 were reviewed in order to identify those articles with links to both history and engineering. While historical criteria were relatively easy to apply, the engineering ones were somewhat more difficult. They were applied in the broadest way and to all of the disciplines. They were applied to articles having no hint of engineering history in their titles as well as to those whose titles had something to do with it. They were applied to articles about people, museums, cities, industries, and geographical regions with underlying connections to engineering. As a result, over 300 have been included in the analysis that follows although, in the balance of the paper, only a handful will be discussed. In broad terms, these articles cover subjects which have always been important for Canadian engineering: transportation and communications; the discovery and exploitation of resource materals and energy; and shelter.

In TABLE 1 (on page 3) the 308 articles have been broken down into 18 categories and three time publication periods.

The first of these periods - from 1966 to 1975 - covers the final decade when 12 issues of the Canadian Geographical Journal appeared annually. On average there were five main articles in each issue, or roughly 600 over the ten-year period. Of these, 135 covered subject matter that can be considered engineering-related in a historical context. The leading category was Resource Development/Extraction/Processing with 25 articles. During the second period - from 1976 to 1985 - the Journal and the Geographic appeared bi-monthly and each issue included an average of eight main articles, or roughly 480 over the ten years. 120 of them were engineering-related. The leading category was Ships/Boats/Harbours/Lighthouses with 20, followed by Museums with 17. During the third period - from 1986 to 1992 - the Geographic again appeared bi-monthly, and again each issue had an average of eight main articles, for a total of around 340 for the seven-year period. However, the number that were engineering-related dropped to 53, the leading category being Pollution/Environment with nine. Of the total of 308 articles that appeared over the full 27-year period, the leading categories were Ships/Boats/Harbours/Lighthouses with 39 articles, and Resource Development/Extraction/Processing with 38.

Another way to look at these 308 articles in a historical context (and the one used in the balance of this paper) is to place each of them in one of four broad groups, as follows:

(1) those that describe/discuss aspects of engineering that were historical at the time of publication;

(2) those that describe/discuss aspects of engineering that have become historical in the years since publication;

(3) those that describe/discuss aspects of engineering with relatively recent historical links; and

(4) those that describe/discuss museums.

TABLE 2 (on page 3) shows the relative sizes of these four groups. The first two - not unexpectedly - are dominant.

TABLE 1

History of Engineering Articles

Category	Time Periods 1966-75	1976-85	1986-92	Total
Ships/Boats/Harbours/Lighthouses	14	20	5	39
Resource Development/Extraction/ Processing	25	11	2	38
Cities/Towns/Villages	14	8	5	27
Arctic/Snow/Ice (incl. Transport.)	12	6	4	22
Aircraft/Airports/Space	10	9	2	21
Museums	2	17	2	21
Energy/Power/Generation/Trans- mission (incl. Hydro & Renewable)	5	9	5	19
Locomotives/Railroads/Trolleys	7	8	1	16
Automobiles/Highways/Roads	7	5	3	15
Building/Construction/Heritage	6	3	6	15
Pollution/Environment	3	3	9	15
Miscellaneous	7	4	3	14
Surveys/Mapping/Remote Sensing	7	4	1	12
Lakes/Rivers/Water Supply & Management	7	1	3	11
Canals/Waterways	6	2	1	9
Research/Research People	0	8	1	9
Bridges	3	2	0	5
	135	120	53	308

TABLE 2

Historical Significance Groups

(1) Historical at time of publication: 114, or 37 percent

(2) Historical since publication: 142, or 46 percent

(3) Recent historical links: 31, or 10 percent

(4) Museums: 21, or 7 percent

Historical at time of publication

An article on Early Transportation in Canada by J.R.K. Main appeared in the July 1968 issue of the Canadian Geographical Journal. It began with the comment that the American Indian never discovered or invented the wheel and so, before the Europeans introduced it, these people made use of domestic animals such as the dog for land transportation - as in the dog travois. The Europeans also introduced the horse, and the horse travois became a natural extension of the earlier one. But let us not denigrate this piece of equipment. As Main has noted:

> One inestimable advantage the travois enjoyed over later and more elegant vehicles was that it never stripped a gear or had a flat. In fact, it never broke down. It was a simple and effective device, well suited to the needs of these highly nomadic people. But it did not measure up to the changing times.

The canoe was developed by the American Indians for water transportation and, when they turned to trapping and trading, it became the oldest commercial conveyance in Canada. The Inuit people had, of course, developed the kayak.

Around 1800 the large birch bark canoe gave way to the York Boat - so called because the first one was built at York Factory. This development was stimulated to a large extent by the competitive activities of the Hudson Bay and North West Companies and the need to save money in the fur trade, the continuing migration of that trade to the Far West, and improvements in the routes across portages. This boat was made from local timber. It was around 40 feet long and 10 feet in width, had a draft of three feet, a mast, and a stout keel which also helped it cross portages. It could be poled, rowed, towed or sailed. (Illust. #1)

The Métis of the Prairies were responsible for the development of the Red River cart. Its main uses in the early days were for farming and for carrying supplies to the annual buffalo hunts and returning with the pemmican and skins. Again the cart was constructed from local materials - wood and rawhide. It consisted essentially of an oblong platform about three feet wide and five feet long, with the outside members extended another five feet to form shafts. A stout cross-beam with rounded ends protruding a foot or more on each side was fixed under the centre of the platform to make an axle. The wheels had no metal tires, and the cart was usually drawn by oxen fitted with conventional horse collars. If made from oak and birch, it had a payload of around 1,000 pounds. With a poplar axle, however, this was reduced to 500 pounds. No grease was available for lubrication, so that dry wood would turn on a dry axle unless some natural bovine products could be pressed into service.

Several articles in the Journal and the Geographic have been about canals in Canada. For example, the issue of September 1974 included one by George V. Sainsbury on Re-routing the historic Welland Canal. Its main focus was the opening in March 1973 of the 13.5 km by-pass from Port Robinson south to Ramey's Bend on the outskirts of Port Colborne, replacing a longer, more winding section of the canal. But the article also described in some detail the development of the Welland from the time that William H. Merritt began work on it in 1824. The article recalled that in 1829 the first ship had ascended the Niagara Escarpment through the wooden locks of the first of the four Welland Canals. Sainsbury then wrote:

> Over the past century, the number of locks dotting the channel has shrunk from 40 to eight. Today (in 1974), the Welland Canal offers the fleet of 730 ft (222 m) lakers and the world's ocean vessels a relatively straight course with few obstructions such as bridges, narrow passing zones, and other navigational hazards. Available draft throughout the system is 27 ft (8.1 m) - an impressive contrast to the 8 ft (2.4 m) available to the users of the first canal.

The January 1974 issue of the Journal included an article on the Shubenacadie Canal - The Canal that bisected Nova Scotia - written by Barbara Grantmyre. Apparently, none of the early Governors of this colony recognized the potential commercial value of the water system that included the Shubenacadie River and the chain of lakes that joined the Bay of Fundy with Halifax. However, in the 1790's this changed. As Grantmyre has noted:

> In 1797 the subject of the Shubenacadie Canal was brought before the Nova Scotia House of Assembly and the sum of 250 pounds was appropriated and a committee appointed to inquire into everything connected with the construction of the canal from Dartmouth Cove through the First and Second Dartmouth Lakes, Lakes Charles, William and Thomas, Fletcher's Lake, the Shubenacadie Grand Lake, thence along the Shubenacadie River to the Basin of Minas. Isaac Hildrith, a civil engineer, and Theophilus Chamberlain, a surveyor, made the survey. Their report, Nov. 15, 1797, estimated the cost of a four-foot navigation would be 3,202 pounds, 7 shillings and 6 pence.

A Bill to incorporate a company to complete the canal was brought before the Assembly in 1798, but it did not pass - for reasons that are not apparently clear, although political influence was involved. The scheme was revived in 1814, the delay having to do with the Napoleonic Wars in Europe and the War of 1812 in North America. However, there were further delays, and two more surveys were made. By June 1825 the cost of a four-and-a-half-foot deep passage had risen to over 44,000 pounds. The company, when it was incorporated in 1826, had capital of 60,000 pounds. One of its Vice-Presidents was Samuel Cunard. Francis Hall was appointed engineer, and Thomas Telford of London, England, was appointed consulting engineer. Hall had earlier been a pupil of Telford.

Ground for the canal was broken on 25 July 1826. The work went badly, and went on for years. Neither Telford nor Hall had experienced North American winters and the damage ice can cause. Debts piled up. Repair costs soared. In 1853 a new company - the Inland Navigation Company - was incorporated to complete it, and Charles Fairbanks was appointed engineer. He continued the work but, by this time, a competing mode of transportation - the railway - had begun to attract attention. Yet Fairbanks failed to see how it would take business from the canal. In fact, the railway destroyed it. The Shubenacadie Canal was opened in 1861, after 35 years of effort, frustration, and deep financial distress. There appears to have been some use made of it for commercial purposes for about eight years. (Illust. #2A and #2B)

There have also been several articles on wind- and water-driven mills. One of these, A History of Windmills and their Place in Canadian Life, by Tom Ritchie, appeared in the March 1969 issue of the Journal. Among Ritchie's comments were these:

> The windmill's superior rival was the watermill which also predated it in Canadian history, the first watermill having been constructed at Port Royal in Acadia soon after the French founded that settlement in 1605. From that time on, because watermills were generally more consistent in operation and more powerful than windmills, many more of them were built. But mill machinery was destined to be driven by power from a source even superior to the watermill - the steam engine...which, within a few decades of its appearance in Canada early in the nineteenth century...had rendered both the windmill and the watermill obsolete as prime movers of mill machinery.
>
> However, on the rural landscape a new form of windmill appeared. Much smaller and more compact than the old type, its windshaft had as many as 18 vanes closely spaced around it, but the diameter of the circle made by the vanes' tips was only five or six feet. A large 'rudder' kept the vanes facing in the direction of the wind. This type of windmill, mounted on simple metal towers 25 to 50 feet high, was used on thousands of farms to pump water. In the early days of the use of electricity in rural Canada thousands more of them were put to use in driving small electric generators which maintained the 'charge' in the batteries employed for lighting and for the operation of radios. But with the

> extension of electric power lines into rural areas the need for 'windchargers' disappeared, as did the need for wind-driven pumps. (Illust. #3)

Other examples of early Canadian engineering are to be found in the wooden covered bridges scattered around the eastern part of the country. An article on them, Covered Bridges in Canada, written by Jacques Coulon, was included in the August 1969 issue of the Journal. Nowadays they are dwindling in numbers as a result of fires, old age, and replacement by steel and concrete structures. However, in the 1960's, some 400 survived. There had been as many as 1,000 in Québec alone at the turn of this century, and 500 in 1940. There were 400 in the forested farmland of New Brunswick at the turn of the century, but only 200 by 1960. Coulon commented that the fishing provinces - where inland roads were scarce - had relatively few covered bridges. He went on to say:

> With the crude, unreliable 'bridges' of old, which were roughly cut timbers fastened together and flung across rivers, commerce and communications were suffering greatly. Merchants, travellers and military couriers had to travel at the risk of breaking their necks. So the bridge topped with a roof - the first one was built across the Schuykill River at Philadelphia in 1805 - was designed to shelter the floors from the rotting effects of sun, wind, rain and indiscriminate snow storms, but snow had to be spread over the flooring in winter to help the sleighs and bobsleds travel through. The covering on them was strictly for practical purposes. If a wooden uncovered bridge lasted about ten years, roofed ones had a life expectancy of 80 years, and sometimes more.

Speaking of wood, two special types of boat deserve some attention. The first is The Pointer Boat, and its development has been described by Brenda Lee-Whiting in the article of this title in the February 1970 issue of the Journal.

In the mid-19th century when the lumbering era on the Ottawa River and its 20 narrow, winding tributaries was at its height, the famous J.R. Booth suggested to John Cockburn - a skilled carpenter, woodcarver and boatbuilder - that a rugged, shallow-draft boat was required to help log-drivers push and pull hewn timbers on their way from the tributaries to the main river where they could be rafted. The result was a type of boat, from 16 to 50 feet in length and pointed at both ends, which became known as the Cockburn Pointer, the Pembroke Pointer, or the Ottawa Valley Pointer. The first of them was built in Ottawa under contract to the Booth Company and hauled by horse and sleigh to the site of the logging operations. But as these operations moved further and further from Ottawa, and as their worth became established, Cockburn moved his business in 1865 to Pembroke - 100 miles nearer many of these operations. This move was also wise since the railroad reached

Pembroke in 1876 and tracks were laid just behind Cockburn's sheds. And as Lee-Whiting has noted:

> The raw materials were...obtained from the vicinity of Pembroke, mainly from the Québec side of the Ottawa River; white pine was used for the planking, white cedar for the boat ribs, red pine or white spruce for the oars and yellow birch or white oak for the paddles. The wood was air-dried for 12 months in a shed alongside the boat-building workshop. (Illust. #4)

Another type of boat associated with lumbering was the steam-driven, amphibious one known as the warping tug or 'Alligator.' Again the article - The Alligator - Unique Canadian Boat - was by Brenda Lee-Whiting and it appeared in the Journal in January 1968. This boat was used mainly in the northern areas of Ontario and Québec, as well as in the United States from Maine to Michigan, where shallow lakes connected by narrow rivers made log movement more difficult. A Canadian, John Ceburn West, devised a solution to this general log movement problem in 1889 by designing and building the Alligator. He secured both U.S. and Canadian patents for this craft, and the firm of West and Peachey in Simcoe, Ontario, built it for use on both sides of the border.

West, himself, was neither a lumberman nor a boat-builder by trade. He and Peachey had gone into the foundry business, principally to make sawmill machinery. But the Alligator became the firm's principal product and its construction continued there until 1932 when another company took on its manufacture. This was still continuing in 1968. There were two main models: the smaller was 37 feet long and 10 feet across and drew 30 inches to the bottom of the runners; the larger was 45 feet long and 11 feet across but drew only 26 inches. (Illust. #5)

The 'basic' Alligator had a 12 hp steam engine, and was a combination of a steamboat and steam winch. The engine could drive either the paddles on each side or a cable drum that held a mile of 5/8 inch steel wire cable. The author noted:

> The winch was used when logs were being hauled. The boat dropped anchor up the lake and then moved back to the logs, unwinding the cable. Hooking on to the boom of logs by the boom post at the rear, the Alligator then winched itself and the logs up the lake...
>
> The boat was sufficiently powerful to move a bag boom containing 60,000 logs if there was no wind to interfere, or 30,000 logs against a head wind...the draft of the boat was shallow enough to clear most underwater obstacles...
>
> The hull of the boat was scow-shaped; the bottom was

constructed of three-inch white oak plank, the sides of pine six inches thick, laid in white lead. Steel boiler plate covered part of the bottom and all up the bow of the boat. On the flat underside two runners were placed six feet apart, each one being six by eight inches and shod with steel or iron. It was on these sturdy runners that the boat journeyed along a portage.

The boiler, fed with three-quarters of a cord of wood, could furnish sufficient steam to warp for ten hours. In order to keep it level when going up or down hill, the boiler was hung on an axle in the centre, a screw being arranged on the front end to enable the fireman to tip the boiler forward or back.

The Alligator's speed - forwards or backwards - when travelling on its own as a steamboat was around five miles and hour. It was claimed that the craft could portage a gradient of one in three. The 'modern' version of the boat had a steel hull, a diesel engine, and a pointed bow.

Canadians may have to be reminded from time to time that the first commercial oil well in North America was opened up in Canada - not the United States - by James Miller Williams in 1858 at Oil Springs, a small village in the Township of Enniskillen in Lambton County, Ontario, some 16 miles southeast of Sarnia. The story of this and subsequent early Canadian oil field activity was told in the article <u>Oil, Then to Now</u> by Jean Elford and Edward Phelps that appeared in the November 1968 issue of the <u>Journal</u>. Williams' well went down a year later than the world's first - in Rumania - and a year before America's - Drake's well in Pennsylvania.

The original geological report on the Enniskillen gum beds was written in 1851, as a result of which the area around them was bought by Charles Nelson Tripp, who intended to make japan, asphalt for caulking ships, and varnishes from the seepage and the underlying oil. But although Tripp won a prize for his asphalt at the 1855 Paris Exhibition, he had no means of getting the necessary production equipment to the site, or his products out, and his land was put up for sale. Williams acquired the land and discovered the abundant supply of mineral oil. He was also fortunate that, in 1858, the Great Western Railway completed its Sarnia to London line which enabled him to get his equipment in and his crude product out for refining and marketing at Hamilton. He also won medals - at the 1862 International Exhibition in London, England - for being the first to produce crude oil, and for his samples of refined oil.

The authors noted that Williams' success soon led to the area around Oil Springs being riddled with similar wells, all of which were pumped by hand. They went on to say that, by 1860, the oil men were drilling rather than digging their wells, using the spring-pole method. A line and bit were lowered on a string of ash poles hung from a beam, which rose and fell through the power provided by a man throwing his weight off and on a teeter-totter arrangement. Hugh Nixon Shaw, using this device, took from June to January to sink a well 240 feet deep. He dug the first 50 or so feet, cribbed them with logs, and then employed the spring-pole to take his bit into the limestone. On Friday, 22 January, 1862 his well gushed 20 feet into the air, and was still gushing the following Monday. One result of this wasteful flow was that Shaw began developments that led to the 'Christmas Tree' which was later used to regulate the flow of crude oil from wells.

A series of marketing and other setbacks during the later 1860's - such as the offensive odour of the oil - effectively took the Oil Springs product off the market. However, the field at nearby Petrolia began to flourish. The offensive odour was also modified. But by 1873 competition from the U.S. had reduced Canadian sales. During the period of depression that followed, as well as in later years, drillers from the Lambton field took their skills to Alberta and the U.S., and abroad to countries such as Borneo, Burma, Sumatra, Russia, Venezuela, and Australia. The authors have noted:

> In drilling, they used a cable tool that dropped a bit to pulverize the rock. It had evolved from the spring-pole Shaw first used in Oil Springs. Cheap to run up to a depth of 1,400 feet, it served well on new fields but gave way to the rotary drills starting about 1926.
>
> On the home front several innovations appeared in the seventies and eighties, among them underground storage tanks and the jerker system of pumping. The storage tanks originated after the surface of 33 acres charred to cinders in a $75,000 fire that consumed 40,000 barrels of oil in 1867. The presence of natural gas that came in with the oil led to this fire and to a number of others, and to considerable loss of life (including Shaw's)...With oil stored in wooden tanks, fire always presented a hazard...
>
> J.H. Fairbank, a prominent Petrolia oilman, invented the jerker system of pumping, doing away with the need for a separate engine for each well. A horizontal wheel, activated by an engine, controls the movement of a series of rods laid down two feet above the ground and running from well to well. The jerker rods still keep the pumps nodding on the old Lambton field...(Illust. #6)

The authors went on to say that the earliest tank car in the Canadian oil industry appeared in Lambton in the form of a barrel mounted horizontally on a waggon frame. The first tank cars that the Great Western Railway ran into Petrolia on the spur line opened in 1866 consisted of vertical wooden tanks erected on flat cars.

In 1878 the Michigan Central Railroad ran a line into Petrolia and broke the Great Western's monopoly and the higher freight rates it had charged - in the interests of refiners to the east - for the refined product, in comparison with crude. This made possible the development of effective refining capacity at Petrolia, which became the first home of Imperial Oil.

It was not until 1881 that deep drilling began again in the Oil Springs field. The oil from it went to Petrolia for refining, through a six-mile pipeline, which then became the 'remote ancestor' of very much longer pipelines many years later.

Quite a few articles on railways have appeared in the Journal and the Geographic over the years. For example, the one on Canada's First International Railway by W.E. Greening was in the December 1974 issue of the Journal.

Promoters from Massachusetts and Maine competed to interest Canadian entrepreneurs in schemes that would link the Atlantic Seaboard with the Great Lakes. For the first one, two companies were incorporated: the St Lawrence & Atlantic in Montreal, and the Atlantic & St Lawrence in Portland, Maine. Work from Montreal - south of the river - began slowly in 1846 but speeded up after a number of financial impediments were removed, and Casimir Gzowski became associated with the project. The start was faster in Maine. The two lines met in 1853 at Island Point in northern Vermont, and soon afterwards the first trains ran between Montreal and Portland. The engines of the time were woodburners, and the passenger seats were initially of wood, making journeys uncomfortable. (Illust. #7)

The St Lawrence and Atlantic was sold after 20 years or so to the Grand Trunk Railway and became part of the network that extended westwards into the Americam Mid-West. The Victoria Bridge was built across the St Lawrence to join the two Canadian railways.

Another article, by Vera Fidler, Spiral Tunnels - Engineering Marvel and Tourist Draw, was in the February 1967 issue of the Journal. It discussed the CPR tunnels built in 1908-09 through Cathedral Mountain and Mount Ogden, a few miles west of the Alberta-B.C. border, thereby eliminating what had been called the 'Big Hill' - in regard to which Fidler noted:

> To haul a 15-car train up the Hill required four specially designed 154-ton engines, two in front and two 'pushers' behind. Even then, spinning drive-wheels on a slippery track would sometimes cause a train to stall and its whistle would echo through the mountains until another 'pusher' came to the rescue. But going up was routine compared to the trip down. In a day of wood-burning, hand-braked locomotives, the engineer rode with one hand on the gear bar and the other on the sand valve. At the top of the Hill the brakeman got off and walked

> alongside, watching for signs of heating brakes or sliding wheels, two of the main causes of runaway engines...When a train did get out of control, there was nothing to do but switch it into a spur line and hope for the best.

N.W. Emmott wrote about These Magnificent Royal Hudson Locomotives in the April/May 1981 issue of the Geographic. These steam locomotives hauled the crack trains of the CPR for 30 years but went out of regular service in 1960. Even so, they still exercised an attraction for steam buffs 20 years later. At that time only two Royal Hudsons remained in service - one pulling excursion trains between Vancouver and Squamish in British Columbia, and the other also on excursion duty for the Southern Railroad in the United States.

As Emmott has noted, Canadian railways in the early days specialized in light engines since the challenge was the long distances and not the weight of the freight or the number of passengers - as was the case with the leviathans used in the U.S.. But in the 1920's, when heavier steel cars replaced the wooden ones and the population of Canada grew, stronger locomotives were required. The Hudsons evolved from the Pacifics which had been used in Canada for more than two decades. Emmott wrote:

> The Pacifics could start heavy trains, but their fireboxes could not generate enough heat, nor their boilers produce enough steam to deliver speeds of 70 or 80 mph over long distances. For the engines which replaced them, (CPR chief motive power engineer Henry) Bowen redesigned the boilers and provided a bigger and more efficient firebox. He did this by putting a second axle under the cab, lengthening the firebox, and putting in an extra combustion chamber ahead of the grates...Bowen oversaw the production of the first batch of Hudsons...which were turned out in 1929 by the Montreal Locomotive Works...The new Hudsons were tried out on long runs in the summer of 1930...The success of the first 10 engines led to an order for 10 more, which incorporated several improvements.

These engines acquired their 'Royal' title in 1939 when one of them - No 2850 - pulled the special 12-car train carrying King George and Queen Elizabeth to Western Canada. In 1940 the last five of the 65 Royal Hudsons were delivered. They were designed for use in British Columbia and burned oil to reduce the forest fire risk from flying sparks. (Illust. #8)

From water to land to air. As might be expected of magazines concerned with geography and with Canada, the Journal and the Geographic published a number of articles about aircraft. For example, the Journal in January 1973 carried The Story of the R-100, which had appeared originally in the October 1930 issue (and in the very first Volume of the magazine), giving an account of this airship's successful flight from England to Canada and back earlier that year. Unusually, it had been put together from reports in the Montreal newspapers. The flight itself had been part of a program to develop the use of airships for air communications throughout the British Empire. However, this program was abandonned in favour of a flying-boat service after the R-100's sister-ship, the R-101, crashed in the Alps on its way to India. The reason for repeating the article in 1973 was that the possibility of using lighter-than-air craft instead of airplanes for carrying heavy freight and bulky cargoes was again being studied in several countries in Europe and in regard to the Canadian Arctic.

The R-100 was of rigid design and had a capacity of 5 million cubic feet, a gross lift of 156 tons, and a carrying capacity of about 45 tons. Hydrogen gas contained in a series of balloons within the hull provided the lifting power. Its length was 709 feet, and diameter 133 feet. The engine power was 3,960 hp provided by six Rolls-Royce gasoline engines externally suspended in three cars. In two of the cars were AC automobile engines coupled to dynamos which supplied the electric power needed for lighting, heating, cooking and radio. The airship's maximum speed was 80 mph, and its range at a cruising speed of 71.5 mph and with a full load was 3,500 miles. The article noted that the original intention was to equip the R-100 with either diesel or hydrogen-kerosine engines but, at the time of construction, neither of these types had been sufficiently developed for such an application. The article went on to say:

> The R-100 framework is primarily of duralumin while the principal members of R-101 are of high tensile steel. Although designed to the same specification as to performance, R-100 is totally dissimilar to R-101...
>
> The R-100 sailed from Cardington with 5.4 tons of water ballast aboard. She arrived in Montreal with 9.8 tons, showing that 4.4 tons had been collected during the 79 hour flight from England to Canada. Rain was not alone responsible for this fact, for water was gathered while passing through clouds. The moisture collected on the top of the airship flowed towards the stern, where it encountered a tape that diverted the stream into special ballast tanks aboard. This was the first time that the experiment of collecting water had been attempted...A further advantage was derived in the matter of financial saving. As fuel is burned by the ship's motors, hydrogen must be released to compensate for the loss of weight. If, therefore, additional water can be taken aboard equal to the amount of gasoline consumed, no hydrogen need be sacrificed. On her flight to Montreal, the R-100 used 29 tons of petrol, while only 4.4 tons of water were

collected. It is apparent, therefore, that a considerable volume of hydrogen had to be released, though not an amount equivalent to the weight of gasoline burned up.

On the outward trip from Cardington to St Hubert, the R-100 flew the 3,360 miles at an average speed of 44 mph, securing for Britain the west-bound trans-Atlantic record at the expense of the Americans. The return trip took 20 fewer hours, but adverse winds prevented the airship from taking the east-bound record set by the Germans in 1929. (Illust. #9)

Frank H. Ellis - himself a Canadian aviation pioneer - wrote Bold venture into a northern winter, which appeared in the April 1971 issue of the Journal and which helped celebrate 50 years of flying in the Northwest Territories.

As Ellis noted, two single-engined Junkers monoplanes were purchased by Imperial Oil in New York in the fall of 1920. The Company had decided to buy aircraft in order to get a government geologist into Fort Norman on the Mackenzie River in advance of the spring break-up so that he might make some vital surveys in connection with its already-established oil discoveries. Named 'Vic' and 'Rene' (Ellis's spelling), the two aircraft were flown west and north to a base at Peace River Crossing where their wheel-based undercarriages were changed for specially-designed ski undergears for the first time.

Frank Ellis continued the story of 'Vic' in a second article - Flying Dutchman of the skies - which was in the Journal in December 1973. The work for which the two planes had been bought was abandonned after a series of mishaps. 'Rene' was damaged beyond repair and 'Vic' was put into storage at Peace River. It was bought in the spring of 1922 by the Railway Employees Investment & Industrial Association of Prince Rupert as a commercial venture involving charter trips into the remote areas of northern British Columbia. 'Vic' was converted permanently into a seaplane and renamed 'Hazelton' - the town nearest its new base at Mission Point on the Skeena River. However, the venture failed and the plane was tethered on a high bank of the Skeena for the next five years, open to the wind and weather. (Illust. #10)

In 1929 the 'Hazelton' was bought by a businessman, shipped by railroad flatcar to Tabor Lake, and renamed the 'Prince George' after its owner's nearby home town. As Ellis has pointed out, the years of neglect took their toll on the metal sheathing of the Junkers, but its new owner felt the damage could be repaired. However, he could not get the needed airworthiness certificate and operated it illegally in conjunction with an illegal placer gold mining operation he had in north-central B.C.. The Junkers eventually came to grief during a landing at Stuart Lake in September 1929. Left to rot, it was eventually vandalized. However, the owner removed the propeller and the engine before this happened. He converted the engine into a small air compressor, which eventually disappeared. It was the engine that helped make the plane famous and enabled it to fly throughout the mountain areas of northern B.C..

Hugh A. Halliday wrote about the Laurentide Air Service Limited: Commercial Pioneer in the April 1970 issue of the Journal. The first of the commercial air services that blossomed in Canada in later years, Laurentide started in business in 1919 in the St Maurice River Valley. The Government of Canada supplied two Curtiss HS2L flying boats (G-CAAC and G-CAAD) which had been in storage at Halifax and Sydney, where they had earlier been used for wartime U.S. anti-submarine patrols. The boats were reassembled at the Dartmouth Air Station and flown, by stages, to Lac à la Tortue, some ten miles from Grand'Mère, Québec. Forest survey and protection were the first jobs of the new Air Service. The Company helped to pioneer aerial photography in 1920.

In 1922 the Air Service separated from its parent company - the Laurentide Pulp and Paper Company - and was authorized to: carry freight, passengers and mail; design, repair and manufacture aircraft; undertake photography; and carry out experiments in military aviation. It did not do all of these things, but it did expand into work for other customers and added more HS2L's to its fleet. In 1922, also, an HS2L piloted by Donald Foss was involved in an accident while taking off from a lake 20 miles northeast of Kapuskasing in northern Ontario. This aircraft (G-CAAC) - then called 'La Vigilance' - was considered to be wrecked beyond repair and was left to rot. However, 47 years later the National Museum of Science and Technology retrieved the remains, rebuilt the aircraft, and put it on display. (Illust. #11)

From May to September 1924 the Laurentide Air Service flew mail, passengers and freight into the Rouyn gold fields - the first such regular service in Canada - but it was not financially successful. Added to this were the aircraft losses, accidents and other problems of earlier years. The Company closed down in 1925.

Helicopters: workhorses of the Canadian air was written by Larry Milberry and was included in the February/March issue of the Geographic in 1980. In spite of its relatively recent date of publication, it had a good deal to say about the early days of helicopter operations in this country. Milberry wrote that rotary-winged flight came to Canada in the early 1930's with the arrival of two Pitcairn gyroplanes. These were not helicopters, but aircraft powered by traditional aircraft engines, with lift provided by a big free-wheeling rotor. The gyroplane enjoyed some popularity in North America and Europe from the late 1920's but, for 20 years, the Pitcairns were the only gyros registered in Canada. One was operated by Leavens Brothers in southern Ontario until the early 1950's. Milberry went on to say:

> Canada's first helicopter appeared in 1938. (The three Froebe brothers), farmers by occupation but tinkerers on the side, designed, built and flew this pioneer machine. The project was centred on their farm in Homewood, Manitoba.
>
> The Froebes' helicopter was small, and it resembled a flying bedstead. Mounted on an ungainly-looking frame were a Gypsy II engine, a pair of counter-rotating vanes or rotors, a fuel tank, and a pilot's seat. With rudimentary knowledge of flying, Douglas (Froebe) made the first successful flight in late 1938.

On this flight, the machine was found to be nose-heavy, and adjustments were made. But a more serious problem with the rotor hub bearings appeared later, which the Froebes could not rectify, and the project was abandonned. However, their machine survived and became part of the collection at the Western Canada Aviation Museum in Winnipeg.

The next group of Canadian helicopter pilots were the six who trained on the Sikorsky R-4 machine with the United States Navy during World War II. This machine was the first of its kind in the world to be mass-produced. One of these pilots helped set up the first RCN helicopter unit at HMCS Shearwater in 1951. One Canadian civilian pilot was also trained by the U.S. Army before the War's end.

In 1946, Bell Aircraft set up a helicopter training school at Buffalo and a number of Canadians enrolled in the mechanics' and pilots' courses, some of the latter being former fighter pilots who could not find jobs flying conventional aircraft. One of the graduates of this course ferried the first Canadian-registered Bell helicopter to Toronto in March 1947, for delivery to the Photographic Survey Company Ltd. It was soon put to work - on forestry patrol in northwestern Ontario for the Department of Lands and Forests. Other graduates flew Bells in different parts of Canada, on a variety of jobs, and with varying degrees of success. One of the companies that began in a small way about this time was Okanagan Air Services, which later became Okanagan Helicopters Ltd. - the operator of one of the world's largest helicopter fleets. Another active owner/user of helicopters was the federal Department of Transport which pioneered the use of these machines for reconnaissance and communications work alongside icebreakers in the Arctic.

The difficulty of producing a Canadian-designed and -built helicopter was illustrated in Mulberry's article. He wrote:

> In 1945, a Polish aeronautical engineer, Bernard W. Sznycer, came to Montreal from New York. Sznycer was a pioneer in helicopter design in the United States during

> the War...(He) accepted the offer of a group of Montreal financiers...to finance development of a small helicopter for Canadian use.
>
> Sznycer, aided by Selma Gottlieb, a mathematician from Philadelphia, set to work and by late 1946 had designed and built a prototype. This was the SG-VI-C, a small three-seater powered by a 178 hp Franklin engine. It was successfully flown for the first time in July 1947 by an American pilot, Henry J. Eagle Jr. He found it an excellent machine, easy on the controls and free of vibration and stick shake.
>
> Though restricted by budget limitations, Sznycer refined his helicopter as the SG-VI-D, christened the 'Grey Gull.' It first flew on February 6, 1948 with much fanfare from the Montreal press.
>
> The SG-VI-D was successfully put through a rigid flight test program and was shown to be as fine a light helicopter as any then in production in the U.S.. Sznycer devised plans to mass produce it, subcontracting the manufacturing of parts. These, he claimed, could be assembled into a complete helicopter with 16 hours' labour.
>
> In March, 1951, despite delays caused by the shortage of development funds, the 'Grey Gull' was certified by the Department of Transport...The test criteria had been based on existing American standards for helicopter certification, but tightened to meet the needs of Canada's environment...
>
> The 'Grey Gull' was also the first helicopter certified in the British Commonwealth. Ironically, its backers chose that time to withdraw their funding. The project folded...

Aerial photography - an early manifestation of what we now call 'remote sensing' - was discussed by H.R. Jackson in What aerial photography does for us, which was published in the August/September issue of the Journal in 1976. The author wrote that photographs taken from aircraft had greatly assisted in the development of Canada, but the technology had not always had the sophistication found in the mid-1970's. The beginnings, he said, were shaky. The first known air photo in Canada was taken over Halifax in 1883 from a balloon. But it was not until World War I that air photos were used for other than 'curiosity' purposes. The air reconnaissance of enemy lines started the technology of aerial photography and its interpretation.

Jackson wrote that, in Canada, the first work on civilian uses of air photography was done in 1920 when an experimental survey was conducted over Ottawa. Since that time the technique has been in continuous use in such sciences as cartography, forestry, agriculture and geology. Recently it has even been applied to sociological studies of population densities, urban sprawl, traffic planning, and industry location.

The article went on to discuss the development of the technologies asssociated with aerial photography from the period following World War I to the mid-1970's.

Historical since publication

This is the largest of the four groups identified above, which may indicate that those who chose the articles for the Journal and the Geographic between 1966 and 1992 had 'noses' for engineering-related material that already had some historical importance, or would acquire it later on. As with the group above, only a handful of articles will be mentioned in what follows and, again, they have been chosen for their intrinsic interest rather than as representatives of the categories to which the 308 articles were assigned in TABLE 1. Most of them were published before 1980.

The July/August 1974 issue of the Journal carried the article by A.I. Wallace and P.J. Williams on Problems of building roads in the north. They outlined the overall problem in this way:

> With approximately 55,000 people scattered over almost 1,500,000 square miles, no form of transport (in the north) can be cheap by southern standards. Also, reliability is difficult to achieve when seasonal changes in the nature of both land and water surfaces mean that over much of the region no one surface mode of transport can be operated all year round, and air movement remains subject to the vagaries of the weather. An all-season highway represents the nearest approach to ensuring a continuously reliable transport system, but even where this is absent, road vehicles play an important role in providing northern transport...
>
> All-season roads are a comparatively recent arrival, there being little northern mileage prior to the hectic period during the Second World War. The most substantial legacy of that time is the Alaska Highway...After the War the Northwest Territories were provided with an equivalent link in the form of the Mackenzie Highway...The most recent phase of development began in 1972 with the announcement that work was to start on an all-season highway (the Dempster) down the Mackenzie Valley from the present terminus at Fort Simpson to Inuvik, at an estimated cost of around $100 million.

Wallace and Williams then dealt with the specifics of the problems of northern roads - for example: the need to adapt existing designs to take account of natural conditions and the need to know about these conditions in order to avoid higher than necessary initial costs; premature deterioration and high maintenance costs; the relatively more serious and frequent problems caused by snow and ice, floods and washouts, potholes, landslides and mud; frost-heaving, water migration and other effects of freezing on different roadbed soils; and the technology of permafrost. They drew attention to the differences in development characteristics between three major regions: the Yukon and Great Slave Lake area; the Mackenzie Valley; and the large expanse to the east of the Mackenzie. The first of these contained most ot the north's then existing road network and road and rail connections to the south. It also had an extractive mineral economy that was dependent on the low cost bulk movement provided by the railways for access to industrial markets. In this context, road transport became essentially a feeder mode for the railway. The main activity in the Mackenzie Valley was oil exploration and extraction, served (in 1974) by river barges in summer. Hence the need for the Dempster Highway. To the east of the Mackenzie, air cargo and coastal shipping - when available - met the current needs of the people who lived there, with the exception of the development of the James Bay project which would need roads from the south.

The authors went on to say that the most intractable highway problems were associated with the periods of spring thaw and freeze-up where all-season routes crossed major waterways. In the absence of bridges, there could be three months in the year when the break-up or the formation of ice would not carry vehicles or permit ferries to operate. They speculated that the use of air-cushion vehicles might help, but that the cost of using them on a part-year basis could rule them out.

George Erskine Inglis wrote on <u>The Mackenzie Highway: Driveway to Canada's Future</u>, which appeared in the September 1969 issue of the <u>Journal</u>. the article described the construction of this highway from Grimshaw in the Peace River country of Alberta through to Yellowknife.

Larry Pynn wrote twenty years later on <u>The Dempster</u> - in the June/July 1989 issue of the <u>Geographic</u>, and provided a number of spectacular illustrations of this highway. At that time it was still North America's only public highway above the Arctic Circle. (Illust. #12)

There was an article, <u>Railway Freight Highballs</u>, by J.L. Charles which appeared in the October 1969 issue of the <u>Journal</u>. In it, the author discussed the influence engineering was then having on rail freight systems and operations - and which has been reinforced with the passage of time. Charles wrote:

> The heart of (freight) train operation is Centralized Traffic Control, with relative automatic signals and electronic communications, whereby one dispatcher - at a panel of push buttons and illuminated diagrams showing the progressive movement of all trains - can direct traffic on hundreds of miles of track...and he can also set the position of power switches for opposing trains to pass without either having to stop, and thereby attain fast schedules and a high degree of line capacity. Masses of data...are processed by electronic computer for management to have at all times a comprehensive summary of the situation.
>
> The sciences, especially soil mechanics and metallurgy, give the technology necessary to construct and maintain stronger track structures to carry increasing axle loads at higher speeds. Clickety-clack of wheels over rail joints is eliminated by welding rails into longer lengths of up to one-quarter of a mile...
>
> The evolution of rolling stock and motive power continues. There are now 20 or more types of specially designed revenue cars to meet customer requirements and to expedite loading and unloading. The diesel locomotive has effected stupendous economy and flexibility, and more powerful units are being introduced. However, if experiments are succesful to perfect a gas turbine or to prove the feasibility of applying nuclear or other sources of energy to railway locomotion under conditions in Canada, the diesel may not remain supreme.

But as we know, these last-named innovations have not yet come to pass.

E.A. Godby wrote on "Remote Sensing": Satellite Pictures of Earth, which was included in the September 1975 issue of the Journal. The author was principally concerned with describing this technique of surveying the earth and with some of the other activities of the Canadian Centre for Remote Sensing (CCRS) - of which he was associate director at the time - including the use of NASA's Landsat I satellite which had been launched into a near polar orbit in late July 1972 and made 14 earth orbits every day, four of which made ten-minute passages over Canada. It transmitted the Canadian data to the ground station at Prince Albert, Saskatchewan. (Illust. #13)

As Godby pointed out, the technology of remote sensing could be used to influence engineering-related decisions and activities in many areas of the earth. He also discussed some of the problems associated with this new technique. He wrote, for example:

> Landsat provides a means by which the public, as well as

> governments, environmentalists and developers, can see what is happening in the isolated areas of northern Canada. However, even with the satellite providing new eyes with which to view the north, the resulting masses of data are so great that some method is needed to reduce the data-processing problem to manageable size. New analysis techniques such as those performed with the Image 100 can help. The Lake Winnipeg-Nelson River power development is one example of how this methodology can work in practice.
>
> By this development, water from the Churchill River is being diverted through the Rat and Burntwood Rivers into the Nelson River to produce hydroelectric power. The level of Southern Indian Lake will be raised by 10 feet, the flow through the Rat and Burntwood Rivers will be increased from 4,000 to 34,000 cubic feet per second, and the level of Lake Winnipeg will be regulated to provide water storage for the power development...
>
> ...A study of the expected impact of this development on the environment has been conducted by the Lake Winnipeg, Churchill and Nelson River Study Board. Satellite imagery will help to assess whether the actual impact is consistent with the predictions of this study.

In his article, Godby described three other elements in the CCRS program: one under which four specially-equipped aircraft were operated for Canadian scientific purposes; one under which new methods, including computerized methods, for analysing remote sensing data were being developed in cooperation with mission-oriented government agencies; and one involving the design and development of sensors.

<u>How computers are improving our maps</u> was the title of the article by Ian Darragh that appeared in the October/November issue of the <u>Geographic</u> in 1979. Maps, he wrote, have - with the aid of the computer - become more accurate than hand-drawn maps and, as refinements are made, it is expected they will speed up the map-making process by 20 to 30 percent. Computers can describe landforms in mathematical language, in addition to drawing items on sheets of paper. Map information stored on magnetic tape may be used either directly in its digital form or made into an image on a cathode ray screen. The largest map-maker in Canada is the federal Department of Energy, Mines and Resources. It was one of the pioneers in this country in computer-assisted cartography - a technology that has been developing since the late 1960's in Canada, the United States and Europe, and the Department's Surveys & Mapping Branch has been particularly active.

The Department of the Environment has used a computer to build up land bank data which catalogues how land is used and where the important concentrations of wildlife are. Statistics Canada has also advanced the techniques of aerial photography (mentioned above in the Jackson article) and has applied computer-made thematic maps to sociological parameters such as population changes, income distribution, religion, unemployment, and mother-tongue in Canada.

Darragh also described particular technologies, instruments and processes associated with computer mapping, and discussed some applications. He wrote, for example:

> Of course, digital terrain information has its limitations. A person looking at a map can compare sizes and distances between features at a glance. Computers have difficulty dealing with spatial relations, but they can save time to solve some problems for engineers and planners.
>
> If a hydro company wants to build a transmission line, it can feed digital terrain data into a computer which will plot possible routes and the location of transmission towers.
>
> An engineer, planning a communication system for, say, a police force, can use digital terrain data to determine the optimum location and height of a transmission tower, so that signals will not be blocked by any heights of land or buildings within the area of the force's jurisdiction.
>
> Engineers of the Surveys & Mapping Branch say the uses of digital terrain information will increase as the obtaining and filing of it becomes more sophisticated...

In the Historical since publication group are a handful of articles on energy resources and their discovery, potential, processing and application in various parts of the world, of which the following are examples, taken in chronological order of publication in the Journal and the Geographic.

Offshore Exploration for Gas and Oil, by C.H. Little was published in the October 1968 issue of the Journal. It described and discussed the origins of underwater resources and exploration methods developed for their recovery in the various parts of the world. The author noted that drilling for oil was carried out from piers off the coast of California before the end of the 19th century and that, in the 1920's, oil was drawn from Lake Maracaibo and the Gulf of Mexico. He went on to say that platforms mounted on piles gave way after World War II to specially designed steel platforms and these, in turn, to the complicated drilling and production units of the 1960's. The latter have usually been floating platforms, or submersible units or self-elevating structures which rested on the bottom.

Energy from Fundy Tides by R.H. Clark appeared in the November 1972 issue. This article has provided a historical and technical description of what might be called 'tidal power engineering' over the centuries since the introduction of 'flap gates' (an example of which may be seen at Grand Pré, in Nova Scotia). Clark drew attention, for example, to the interest in tidal energy which began seriously in the 1940's with the completion of a large plant in the estuary of the River Rance at St Malo in France. Of the Bay of Fundy tides he wrote:

> Not only are the Fundy tides known world-wide for their power, but also for two natural scenic spectacles which the spawn twice a day: the tidal bore of the Petitcodiac River and the Reversing Falls at the mouth of the Saint John River. These two spectacles give some inkling of the power and unrelenting nature of the tide-producing forces.

Fundy tidal power was, of course, the focus of Clark's article. He noted - with regard to the comprehensive federal-provincial feasibility investigation of it tabled in 1969, which included the study of hydraulic machinery and marine construction technology that should be applied - that substantial portions of the large power potential of the upper part of the Bay could be developed at a variety of sites and using a variety of physical arrangements.

Syncrude: full steam ahead by F.K. Spragins, then President of the Company, was included in the February 1975 issue of the Journal. It was based on a paper he had presented to the Ninth World Energy Conference in Detroit the previous September. The article began:

> The Athabasca tar sands...contain an estimated 149 billion tons...of sticky, sulphur-rich oil called 'bitumen.' It is 200 years since the tar sands were discovered; 70 years since they were first mapped geologically; and 25 years since hot-water extraction technology proved feasible. Yet today, there is only one commercial production facility, Great Canadain Oil Sands Ltd., producing synthetic crude from this immense reservoir. (Illust. #14)

Spragins went on to describe the overall tar sands situation in Alberta, the development of the hot-water process and its alternatives, the mining and separation problems, the upgrading and the transportation of the remote resource to market, jurisdictional and environmental problems, and the social problems of the indigenous people and the thousands of others who had to be brought in to make the whole process work.

In concluding his article, Spragins wrote:

> Rapid development of the heavy oils of the Athabasca tar sands in particular is imperative if Canada is to avoid an early, chronic deficiency of oil and gas. The history of attempts to bring the tar sands into production indicates that substantial techno-political barriers must first be crossed. At present, man-made barriers to rapid and orderly development are far more formidable than those imposed by nature or by the lack of scientific knowledge.

To digress for a moment, the negative side of oil production was discussed in Pollution or Poppycock by P.D. McTaggart-Cowan, which was published in the June 1972 issue of the Journal. This article dealt with what became known as 'Operation Oil' - the clean-up of the oil spilled by the tanker 'Arrow' when it foundered on Cerberus Rock in Chedabucto Bay on the Nova Scotia coast in February 1970. McTaggart-Cowan was put in charge of the task force assigned to this Operation. The article was based on a paraphrasing of the address he gave to the Royal Canadian Geographical Society in March 1972 and on the transcript of the rearranged sound track of a film made by Crawley Films for the federal Ministry of Transport.

After the 'Arrow' grounded, it broke in two. The bow section remained firmly on Cerberus Rock, while the stern section came to rest 400 yards to the north in 95 feet of water. About one-half of the extensive shoreline of the Bay was contaminated by spilled thick, black Bunker C oil, a great deal of oil remained loose in the water, and about one-and-a-half million gallons were trapped in the sunken stern. And winter weather complicated the task force's work.

McTaggart-Cowan began his address with a discussion of the general problem of environmental pollution. Interestingly, while rejecting the 'doom and gloom' view of it, he admitted that it was indeed very real, basing his own view on the thesis that much had yet to be learned about pollution and pollutants before we could be sure what the ecological consequences might be in the future. He said:

> Those of us who are working in the area are very concerned about the spread throughout the world of those substances which do not occur in nature - the man-made synthetics, some of which are toxic and many of which are very difficult to bio-degrade...I think we have tended to act too quickly on many of them so I have hope that, as others are discovered, we will take a serious and determined look. Panicking won't help anything - it may put a lot of people out of work, but it won't make the pollution go away.
>
> Now, I think we can clean this up. First of all, we must

> cut out a lot of poppycock that's being spread around the country - the doom and gloom on the one hand and the almighty technological fix on the other - that 'don't bother, just keep on doing it, some scientist will come along and get a technological fix' attitude. Both postures are equal nonsense. It will take a determined effort. We must stick to it, and it will cost money, but I think that we have time if we have the determination. The atmosphere is a very forgiving part of our planetary system. It has a marvellous way of cleansing itself, but there is a limit to the rate at which it can do it. The oceans are the same way. The fresh waters are a little more sensitive.

In any event, for the Chedabucto Bay clean-up, the task force received significant amounts of support from the Canadian scientific community. Operation Oil was underway in a matter of days after the spill. The military were involved, as were civilian engineers, construction experts, salvage experts, wildlife conservationists and others. Industry was called upon to build equipment for the job - in a hurry. In some cases, what was built had to be invented first. Helicopters were used to keep watch on the movement of the spilled oil. A causeway was built to prevent oil migrating to some of the beaches. Booms were used in the water to gather and contain floating oil. Some of the beaches were bulldozed clean. The world's first washing machine for fishing nets was designed, made and delivered in ten days. Anti-pollution seawater filters were devised and installed in the fish plants. Meetings were held regularly by McTaggart-Cowan and his colleagues to brief the local people on the immediate problems, as well as those they would face in restarting their fishing operations in the Bay.

A salvage master, Sven Madson, was assigned to get the oil out of the sunken section. To do so, he borrowed an idea from the refinery industry. As the article noted:

> Navy divers cut holes through the deck of the ship using a method called a 'hot tap.' This is used for tapping into pipelines and reservoirs under pressure and installing new lines without shutting the unit down. It proved to be the solution to penetrating the deck of the ship without spilling the oil.
>
> Bunker C at low temperatures doesn't flow like the oil you put in your cars. Live steam must be forced down hoses to liquefy it. Only then could it be pumped up to the waiting recovery barge, the 'Irving Whale.' Recovery of the oil from the wreck went on 24 hours a day, weather permitting. In less than a month 1.3 million gallons were recovered, the first time anywhere that such an operation had been performed on a sunken vessel.

Many people heard the term 'slick licker' for the first time during the Chedabucto Bay clean-up. Trapping oil on the surface of water is one thing. Getting it out of the water is another, and it was for this job that slick lickers were used. One was a prototype which an Armed Forces aircraft had flown in from British Columbia. Three others were built by a local shipyard. They were relatively simple machines - a conveyor belt covered with layers of canvas and terry towelling. Pushed on to the conveyor belt, the oil and other debris could be loaded into 45-gallon drums for disposal. (Illust. #15)

Can we use the wind to supply more energy? by H.G.Classen appeared in the April/May 1977 issue of the Journal. This article, in some ways, updated earlier ones that had appeared in this magazine, but its place was really as part of the search for alternative sources of energy in response to the perceived crisis of the time.

Classen agreed that wind energy is clean, at least statistically abundant, and could be tapped by anyone with a minimum of investment on a do-it-yourself (DIY) basis. But he was also realistic. A wind-driven, DIY generator with a rated capacity of 750 watts - in the wind conditions of blowy Prince Edward Island - would probably have an output sufficient to light up a few bulbs. At the other end of the scale, the NRC's vertical axis windmill on the Magdalen Islands might generate 70 kw. But 1,700 of them would probably be needed to replace PEI's power requirements using that Island's wind velocities. Something like a million would be required to service Ontario, using Ontario's wind velocities. In addition, the maintenance and transmission problems would be staggering. Classen admitted that his arithmetic was speculative, but it served to emphasize that wind power is a very dilute source of energy. On the other hand, he did discuss some of the new designs being developed and tested in order to improve the situation.

Building and working underground to save energy by Robert F. Legget was included in the June/July 1977 issue of the Journal. The author explained the basis of his proposals in this way:

> The thermal properties of the earth make possible large savings of energy when buildings or facilities are placed well below ground level. This is easily explained if thought be given to ground temperature. Daily variations of temperature are experienced only for a relatively short distance below the surface. Beyond this, the earth temperature will vary only seasonally throughout the year...With increasing depth, even this seasonal variation will gradually decrease until, at a depth of about 25 feet, the temperature remains almost constant throughout the year.

The author cited a number of examples of underground living and working around the world, dating back to the catacombs of Rome and beyond. Canadian engineers, he wrote, had experience in tunnelling and other aspects of the construction of underground facilities such as power houses, defence installations, shopping malls and garages. They had been responsible for tunnelling the White Cliffs of Dover to make space for a complete communications centre during World War II.

The Classen and Legget articles have become 'historical since publication' in the sense that the engineering proposals they discribed and discussed have not been applied as extensively as might have been expected at the time of writing for the purposes of saving energy - regardless of their intrinsic merit. A third article - written at a time when increased effectiveness in future energy use was being proposed in combination with a swing from oil to electricity - was Why nuclear energy? and is it safe enough? by Ken Webb. It was written with particular reference to Ontario and the already large commitment of Ontario Hydro to the use of nuclear power for the generation of electricity, and was published in the August/September 1980 issue of the Geographic.

Webb wrote:

> Accepting for now the inevitability of increased reliance on nuclear power, we come to another question. How safe is nuclear energy? Over the past year and more, television, radio and newspapers have dramatized risks associated with the nuclear option; have they exaggerated them? How uneasy should the people of Ontario and other Canadians feel toward the nuclear future to which their governments and public utilities are committting them?

The article went on to discuss at length the mechanics of nuclear power generation, and also the development program of Atomic Energy of Canada Ltd., at the end of which the author concluded:

> Personally I find that nuclear energy, at least in Canada, is not as essential as asserted by its advocates; nor is it as dangerous as asserted by its opponents, or in much of the newspaper, television and radio coverage during and after the accident at Three Mile Island. How do you feel?

Webb's article was, of course, written in pre-Darlington and pre-Chernobyl days.

Turning now to aircraft, the April/May 1981 issue of the Geographic carried the article by Lydia Dotto on STOL Dash 7 conquers the toughest geography. Dotto wrote that the design of a STOL aircraft like the de Havilland Dash 7 (and its predecessor, the Twin Otter) allows it to descend and climb at steep angles and to fly safely at slower speeds than conventional aircraft of the same weight. Its ability to use shorter take-off distances in hot or thin air has made it attractive to airlines operating in hot climates or at high altitudes. And it happens to be quiet in operation, and fuel-efficient. Dotto also said:

> The economic ramifications are significant. De Havilland president John Sandford has said it may be possible to build three or more STOL runways for the price of one jet runway. It is not just that the shorter runways are cheaper to build; the total cost of an airport, which includes such things as land purchase, clearing of terrain, and building of taxiways and other facilities, can also be cut sharply. In some cases - mountainous, tree-covered or Arctic regions, for example - longer runways may not be possible.

Built at the de Havilland plant in Toronto, Dotto noted that, by mid-January 1981, a total of 125 Dash 7's had been delivered, sold or optioned around the world. But only six had gone to Canadian customers, and two of these went to the Armed Forces for use in Europe.

The article <u>Canada's impressive role in space</u> by Ian Allaby appeared in the October/November 1981 issue of the <u>Geographic</u>. Allaby began by reminding his readers that the Canadian-designed mechanical arm - the CANADARM - which had attracted so much attention through the U.S. Space Shuttle program was only the most recent addition to the country's line of successful space engineering products. Canada in fact was the third nation to join in the so-called 'space race.' The artificial satellite - Alouette I - went aloft in 1962, and many more had gone since then. He then wrote:

> What prompts this strong showing in outer space from a country with a smaller population than the superpowers?
>
> True, Canadians are stretching, as we always have, to keep up with the leading nations in high technology. But more than that, our space effort springs from our perennial struggle to master and maintain sovereignty over a great landmass and its three bordering oceans. Four oceans, we should say, if we include the limitless one above.

Allaby said that, following World War II, Canadian scientists interested in space simply tried to learn more about the upper atmosphere using radio waves from the ground and by launching balloon probes. Of special interest was the ionoshphere, beginning about 55 km up, off whose layers long-distance radio signals could be bounced, especially in - and for - the North. In 1957, as part of a joint Canada-U.S. project for the International Geophysical Year, a rocket range for studies of the ionosphere was established at Churchill, Manitoba. This location was favoured for two reasons. The spent rocket stages could be designed to fall into Hudson Bay while the instrumented nose cones would descend by parachute and land on the tundra. And it was an area where the aurora borealis phenomenon - which could disrupt communications using the ionosphere - were frequent and intense. This was the 'bottom-up' approach. Using data transmitted from Alouette I, which was designed and built at a defence research establishment at Ottawa, it was possible to chart the ionosphere and examine the aurora using a 'top-down' approach. This satellite continued to send signals back from space for a decade, very much longer than the transmission life initially expected from it. Three subsequent satellites - Alouette II (1965), ISIS I (1969), and ISIS II (1971) - each functioned for at least 10 years on similar missions.

In spite of their success, the Canadian research satellites were superceded by communications satellites - in view of the importance of national telecommunications for the political survival of the country. As Allaby noted:

> ...No surprise, then, that this nation leaped to world leadership with its (communications) satellites.
>
> In 1972 Telesat Canada, a union of government and private enterprise, sent up Anik I (later known as Anik A-I), the western world's first domestic communications satellite. It was soon followed by Anik A-2 and Anik A-3...
>
> Approximately, the Aniks are poised in space above the equator about 2,700 km west of Ecuador, with a few degrees of longitude separating them. They are within range of all Canada up to the High Arctic.

The Hermes satellite followed in 1976...When Allaby wrote his article it was planned that Anik D satellites would be sent up by rocket and Space Shuttle, and Anik C's would go up by the Shuttle too...By the year 2000 Canada might be putting a space-lab into orbit to permit the testing of industrial processes in zero gravity. Solar energy satellites were another possibility mentioned.

As has been noted in an earlier article (on page 20), Canada has made use of the American Landsat satellites for remote sensing purposes. Indeed, as Allaby wrote in the last paragraph of his article:

> ...the great irony is that, even though the Canadian space program is focused mainly on our narrow national goals, the very adventure in space - with the larger perspective this offers of the planet - encourages international cooperation and may enlarge our service to all mankind.

Recent historical links

The 31 articles in this group include a number of very recent ones whose subject matter may only have historical importance quite a few years from now. For this reason, the number discussed is much smaller than for the first two groups, the discussions themselves are much briefer, and there are no illustrations.

Max Perchanok wrote the article on Testing a new breed of icebreaker which appeared in the June/July 1988 issue of the Geographic. The icebreaker in question was the 'Kalvik' - commissioned in 1983 by Beaudril, a division of Gulf Canada Resources Ltd.. It is a small but powerful twin-screw vessel with a spoon-shaped bow and a low stern, which was designed to service oil rigs in the Beaufort Sea. The testing took place among some of the toughest ice in the Arctic Ocean, near the Dundas Peninsula in Viscount Melville Sound. The time was the late summer of 1986, and one of the objectives of the testing was to see if some of the design features should be incorporated into future Coast Guard icebreakers. The CGC's own icebreaker, the 'Sir John A. Macdonald', provided both back-up support and performance comparison. The author summarized the results of the testing this way:

> The on-the-spot conclusions of the captains were similar to those eventually reported by Artec Canada Ltd., the engineering firm I was with which carried out the technical measurements.
>
> The 'Kalvik's' spoon-shaped bow, its high power and small displacement give her icebreaking capability that is the equal of the larger Coast Guard icebreakers.

However, Perchanok went on to say that several other features of the design inhibited the ship's ability to fulfill some of the Coast Guard's requirements. The parallel sides restricted her ability to turn out of an already broken channel - an important manoeuvre while escorting cargo ships - and ice chunks tended to ride up onto her stern when going astern. In addition, she left a broken track of ice that was not cleared and was too narrow for many other ships to follow. Clearly, he concluded, the design must be further refined before it could be adopted for use in Coast Guard ahips.

Jim Algie opened his article Plowman spare that field - which appeared in the October/November 1988 issue of the Geographic, and which had the sub-title: Age-old autumn ritual challenged because of concerns about erosion - with the following paragraphs:

> Don Lobb doesn't plow at all on most of his land in Ontario's Huron County. When he plants he drives the seeds directly into the soil through the stubble of the previous crop. Locally, farmers speak of him as 'the

father of conservation farming.' His farm slopes up a long rise in the lower Maitland Valley near the Lake Huron port of Goderich.

Farming remains the foundation of the local economy here. But it is all hill farming in Huron County, and the special problems of holding soil on rolling cropland have made farmers like Don Lobb pioneers of an agricultural style that shuns the black soil model of the well-plowed field. On hilly land, under conventional tillage practices, surface water carries away topsoil by the tonne. It is estimated that a million tonnes of sediment runs off into the Great Lakes from Ontario farms annually.

Lobb has responded to the problem by avoiding tillage as much as possible with what is known as 'minimum-till' or 'zero-till' agriculture. He is one of a growing number of farmers and agricultural experts busy revising tillage concepts and farm implement designs that have held sway for hundreds of years.

The story of the testing of a solar power system in wintertime at Long Dog in remote Northwestern Ontario was the subject of the article Capturing the sun: solar power brightens a Northern Ontario village by Per Drewes and published in the October/November 1989 issue of the Geographic.

The author was, at the time of writing, an alternative energy design engineer with Ontario Hydro. As he explained, Long Dog was one of several settlements discussed as potential sites for solar-power projects. He had been experimenting with a small power supply run by three solar panels and a battery pack. The batteries, recharged by the panels, could run a 12-volt electrical system operating a few lights, radios, appliances and power tools. Such a system had been under test in the Toronto area for about a year. The objectives of the Long Dog project were to put this experimental system to work in a remote community, figure out the best method of installation, and then determine if it met the needs of the residents.

Almost 700 kilograms of solar equipment, batteries, lighting fixtures, and boxes of tools and materials were flown into Long Dog in an old de Havilland 'Twin Otter' along with the author and a colleague. Six of the ten houses were hooked up before the author and his colleague left, the four others remaining unoccupied.

The article itself was mostly an entertaining account of the five days the two men spent installing the solar system at Long Dog and training the permanent residents to operate it. The article, however, attracted a great deal of attention. Ian Darragh, in his Editor's Notebook in the August/September 1990 issue of the

Geographic, recounted some of it. It appears that Drewes was swamped with letters and telephone calls from cottagers, a gold panner in the Yukon, a trapper in Manitoba, and high school students in Saskatchewan, among many others. He set aside other projects, produced one brochure on solar energy and another on wind power - and he went back to Long Dog to find out what had been happening there. Darragh wrote:

> Ballasts had burned out in two of the high-efficiency fluorescent lights, but aside from that, everything was working fine. He was told there was not enough sun for a few days in November and December to keep the storage batteries charged, and villagers had to go back to naphtha lanterns. But come January, everything was up and running again, including the TV and the videocassette player Drewes donated to the community. Next to the lights, it was the TV they appreciated most during the long winter evenings.
>
> Another change is that Long Dog is now a little less isolated. The community had been asking for telephone service for years, but without electricity, there was nothing Bell Canada could do. Now the village has a telephone in the Band office powered by one of Drewes' 180-watt photovoltaic arrays. The antenna links the community to a conventional telephone exchange, and villagers can now call for help in medical emergencies or make direct-dial calls anywhere in the world, for that matter. Previously, Long Dog had a small battery-operated radio, which was often unreliable.

The 60th Anniversary issue of the Canadian Geographic was published in December 1989/January 1990. It included an article by Russell McNeill called Search for the fuel of the future: David Scott and the dream of hydrogen. Scott was at that time a professor of engineering at the University of Victoria, having recently left a similar position at the University of Toronto. In 1984 he had been the founding director of the Institute for Hydrogen Systems. He was described by McNeill as an environmentalist, energy analyst and visionary, and the article is as much about him as it is about hydrogen and other energy systems. For example, Scott was quoted as having said that a tree may be thought of as the perfect technology. It obtains its energy needs by extracting hydrogen from water and combining it with carbon using solar power, the only 'waste product' being oxygen. The solution to our environmental problems will be machines that imitate nature. If we are to survive, it is clear that technologies must evolve that are harmonious with the environment. Nothing about the internal combustion engine mimics nature. Current technologies are intrusive, and are right out of phase with how civilization is evolving.

The last paragraphs of the article gave the author's summing up. McNeill wrote that Scott believed the patterns of history pointed to hydrogen. He then quoted the professor directly:

> 'We could not have flown to the moon on oil or gasoline. We did it on hydrogen. We did it because hydrogen is a better fuel than oil, just as oil is a better fuel than coal. We always do the toughest jobs with the newest fuel. The Space Shuttle uses hydrogen. Now we are ready for the next toughest job - the next generation of aircraft. After that we will almost certainly look at locomotives. The car is easier still, so it will be much further off.
>
> 'The technologies we are moving towards will mimic nature in an almost eerie way. But we do not have the billion years it took nature to evolve to where we are now. We have to do it using the one great thing that evolution gave us - intelligence. We have to do it using our intellect alone, and we probably have to do it in less than a century. If we do not, we will destroy the planet.'

Finally, an article on Toronto's First Canadian Place by Charles Wilkins appeared in the October/November 1991 issue of the Geographic under the title The Vertical City: A day in the life of Canada's tallest skyscraper. It rises in two towers - the 72-storey First Bank and the 36-storey Exchange - above the city's downtown core. Built by Olympia and York Developments Ltd., its main tenants are the Bank of Montreal and the Toronto Stock Exchange. Among the features of this building mentioned by Wilkins were:

- the larger tower (then) ranked 17th on the list of the world's tallest buildings;

- in a high wind this tower will sway as much as 67 centimeters at the top;

- 30,000 people work in the building, and they use 30,000 phones;

- there are 58 elevators in 29 shafts;

- expenses for electric power for 1991 were estimated at over $6 million, and real estate taxes at $30 million;

- there are 26,000 automatic sprinklers, as well as fire alarms;

- the building generates more than enough heat from sunlight, its own artificial lights, and the body heat of the 30,000 to meet their needs while working there;

- environmental, recycling, energy-conservation and waste-reduction programs are in place and apply to the operation of the whole building;

- city water pressure is boosted to 450 psi to reach the top floors, but local valves reduce this pressure to the working level on each floor;

- in the event of a blackout, four 700 hp generators would be activated;

- the outsides of the windows and the marble slab curtain walls are washed remotely by an automatic window-washing machine which moves vertically and automatically, and which moves around the building to wash each window six times a year.

First Canadian Place was completed in 1975. It will be interesting to review the experience of 25 years of operation in the year 2000.

Museums

There seems to have been a watershed year in regard to the opening and operation of museums in Canada: the Centennial Year, 1967. It apparently persuaded sponsors, funding sources, city fathers and others that Canadians are interested in seeing some real evidence of the past in this country. The result has been that a lot of new museums were opened, and some of the older ones have gotten bigger.

For the most part, the 21-article Museum group identified in the analysis at the beginning of this paper belong to the period between 1976 and 1985. For the most part, also, the articles are about the larger museums in Canada, although some of the smaller ones have also been covered. The half-dozen or so descriptions that follow are intended to be representative of both the museums and the articles. Several have accompanying illustrations.

The October 1968 issue of the Journal included one on the National Museum of Science and Technology: The National Aeronautical Collection, written by Harry McDougall when this Collection - one of the largest and most varied in the world - was still housed in two old RCAF hangars at Armed Forces Base at Rockcliffe at the eastern end of Ottawa.

Of the Collection's origins, McDougall said that a small selection of historic aircraft was already being maintained in Canada prior to World War II. They were held by the Canadian War Museum and the National Research Council and were survivors of World War I. In 1945, when thousands of aircraft were headed for the scrapyard, the RCAF recognized the desirability of preserving representative examples and began to set some aside. In 1958 the older NRC aircraft were restored and put on display with the more modern ones as the National Aeronautical Collection at the Rockcliffe Base. Concurrently, a large number of models, mementoes, and other artifacts from the early days of aviation in Canada were assembled from various sources and the National Aviation Museum was established. McDougall went on to say that, initially, this Museum was part of the Department of Northern Affairs. Later it became part of the Human History Branch of the National Museum of Canada and occupied an upper floor of the Uplands Airport terminal at Ottawa. Some full-size aircraft were also put on display in an adjacent building.

In the 1960's the National Aviation Museum became the Aviation and Space Division of the new National Museum of Science and Technology (NMST), and the aircraft, engines, etc. belonging to the National Collection became the responsibility of the NMST director. The artifacts in the Uplands terminal - but not the aircraft - and a representative selection of the planes from Rockcliffe were transferred to NMST's new premises at St Laurent Boulevard in Ottawa for exhibition as space permitted.

In the 1960's the range of aircraft types in the National Aeronautical Collection included the Curtiss Canuck - a modified Canadian-built version of the Curtiss Jenny, the de Havilland Cirrus Moth, the Junkers W-34, the Fairchild 82, the Lysander, the Spitfire, and a Sabre used by the RCAF Golden Hawks aerobatic team, as well as a Nieuport 17 and Sopwith Camel from World War I, a Pitcairn autogyro (from the U.S.), and a Bell helicopter. Also - as mentioned earlier in this paper - about the time McDougall's article appeared in print, NMST was becoming involved in the process of recovering and restoring the HS2L that had belonged to Laurentide Air Services and had crashed on take-off from a lake in Northern Ontario.

(In 1988 a new, specially designed Aviation Museum to house the National Aeronautical Collection - located on Ottawa's Eastern Parkway - was opened to the public, and the Collection itself moved from Rockcliffe.)

The <u>Ontario Science Centre</u> was not opened until 1969, but it was a Centennial project of the Ontario Government. It was then, and still is, housed in a group of special buildings in a park along the Don Valley in Toronto. John Tuzo Wilson, then director-general, wrote about it in 1976 in the March/April issue of the <u>Journal</u>. His account was especially interesting because he discussed the <u>engineering</u> behind the Centre's exhibits as well as the operation of the Centre itself. For example, in his text Wilson wrote:

> In just six years the...Centre has become the second most popular of the 20 science centres in North America and is among the most visited of all museums in the world. Since its object is to increase awareness of science, this

> attendance is an excellent measure of its achievement...
>
> What accounts for the stunning success of the Science Centre?...
>
> (Its) greatest appeal...and the aspect that differentiates it from other museums, is the high proportion of exhibits which involve action and participation. The latter may entail turning cranks, pumping water, pushing handles, moving sonar devices, tracing patterns, operating computer keyboards, or just watching short films. Here expertise in design, construction and maintenance is important. When the centre opened, commercial exercising machines, built to withstand a lifetime of use in a private house, were installed. After a few months' continuous use, they had worn out; now the staff build their own...
>
> Mechanical counters show that some exhibits are actuated over a million times a year, once every 10 seconds. Experience has shown which types of projectors, electric motors, push buttons and other devices are most reliable, but replacements are always at hand. All shows of films, slides and sound projects are centrally controlled from an air-conditioned room...
>
> The staff of the Centre includes groups of scientists, engineers, teachers, designers and shop workers. Two hundred are civil servants, but others are students and demonstrators who work part-time on weekends and holidays...Canada has not accumulated a wealth of historical material to compare with that of older civilizations, but there are no limits in displaying the universality of science, and the Ontario Science Centre has quickly achieved an international reputation for excellence in this field.

The article by Hugh A. Dempsey on Glenbow Centre: Calgary's new museum appeared in the April/May issue of the Journal in 1977. As the author has noted, the Glenbow started as the result of the 'collecting' hobby of the late Eric L. Harvie, a Calgary philanthropist, who had made his fortune in oil in Western Canada and was determined that it should stay there. He established the Glenbow Foundation in 1954 as a chartiable institution to serve as the base for his personal collection of mementoes of the past. The Foundation grew quickly over the next decade and branched out from conventional fields such as art, books, archives of the west, and Indian artifacts into such fields as photographic collections, farm machinery and pioneer artifacts.

Dempsey noted that Canada's Centennial had its own impact upon Glenbow for, in order to prepare for that occasion, Eric Harvie and his family wished to donate the Foundation to the people of Alberta. This was effected in 1966 when the Provincial Government passed an Act to form the Glenbow-Alberta Institute and donated $5 million to supplement the Harvie contribution of $5 million and the Foundation collection, then worth $10 million. However, by this time, the Glenbow had opened a museum of exhibits in an old sandstone courthouse in Calgary. In 1969 it added an art gallery, while the library and archives had taken over a turn-of-the-century Carnegie library.

Eric Harvie died in January 1975 before his collections became a permanent monument. This happened in September 1976 when the $9 million Glenbow Centre in the heart of the City of Calgary was officially opened by Premier Lougheed. It features three exhibition and five research and storage floors. Thousands of visitors tour the exhibits annually. Scholars work there on research. Schools take part in education programs. Nowadays, the Glenbow provides a significant reminder of Canada's past.

The very next issue of the Journal - June/July 1977 - included an article by Helen C. Howes on The world's largest railway museum. She began by saying:

> It may surprise readers to learn that the largest collection of historic railway equipment in the world is located in the Canadian Railway Museum's trainsheds on a 10-acre lot within a few miles of Montreal. More than 103 locomotives - steam, electric and diesel, railway cars and electric trams are on display as well as various other pieces of equipment, gifts from Canadian and foreign lines and individuals.
>
> The exhibits represent historical and technological development in Canadian railroading and in city transport. The two-storey Hays Memorial Building contains a library of textbooks, documents, manuscripts, maps, prints, railway timetables, tickets, brass nameplates, bells, whistles, lanterns, signals, headlights and other portable items, plus an operating model railway.

Howes went on to say that the Museum - situated on St Pierre Street in St Constant (near Delson) - was the creation of the Canadian Railroad Historical Association, which was founded by a group of Montrealers in 1932, and which was chartered as a non-profit corporation in 1941. Dedicated to historical research, its activities developed in earnest after 1945 and led to the establishment of the Museum. In 1961 a division of Domtar Chemicals Ltd. gave the Association the St Constant site, and the construction of a building began. A spur was also constructed to connect the Museum with the CPR tracks, which also gave it access to several other railroads. By 1964 the Association had acquired 50 pieces of rolling stock. Members gave their time and labour to the improvement of the collection and the facilities of the Museum year-round.

Sue McLeod's article, Maritime Museum: at last, a home of its own, was published in the June/July 1982 issue of the Geographic, just months after the $7 million Museum opened. But, as she pointed out, Halifax's new Maritime Museum of the Atlantic had its origins in 1947 when Captain Plommer, the Commander of the Dockyard, suggested to a group of fellow naval officers that they pool their artifacts and memorabilia to form a museum.

The Maritime Museum - a private Society - was formed a year later and its exhibits were housed in a small brick building in the Dockyard. In 1950 it became the Maritime Museum of Canada, but the next 30 years were difficult ones. In 1953 the Dockyard building was demolished and the Museum was moved into space in the Halifax Citadel. But its collections grew so fast that it soon needed new accommodations. In 1962 temporary housing was secured in a warehouse on Hollis Street. In 1965 it moved to an old naval bakery building, but this - too - was demolished in 1967. The Society had the choice of disbanding or of becoming part of the Nova Scotia Provincial Museum. It chose the latter, and began to enjoy increased financial resources although, initially, exhibit space was limited. However, in 1975 the Halifax Waterfront Development Corporation proposed that the Maritime Museum section of the Provincial Museum be incorporated into the city's waterfront revitalization plan. The formation of the Maritime Museum of the Atlantic (MMA) was announced three years later when property was also acquired and renovations begun. In addition to this and other newly built exhibit space, the MMA - when it opened in 1982 - included the CSS Acadia, a pioneer vessel in hydrographic surveying that worked from 1913 to 1969, the wharf where she was docked, and an observation deck overlooking the Acadia and the harbour. (Illust. #16)

This quotation is from the article by Eric S. Grace, 'Science North' unveiled in Sudbury, which was published in the April/May 1984 issue of the Geographic:

> In a masterpiece of symbolism, a gigantic 'snowflake' now rests on a massive outcrop of ancient rock which once supported the weight of glaciers. This spectacular building is Science North, a centre of scientific discovery for the public which opens June 19 in Sudbury. It lies on the shore of Ramsey Lake near the city centre, on the fringe of the long oval depression that is the Sudbury Basin...
>
> What formed this 60 km-long Basin nearly 2 billion years ago? How have successive glaciations shaped the landscape and why is the area so rich in metal ores? What is man's history and impact in the region?...These questions are

> answered within the glittering rock walls and exhibits of the white hexagonal building.
>
> Science North contains a wealth of experiences. It has five theatres for demonstrations that involve audience participation; laboratories where scientists illustrate electromagnetic and mechanical phenomena, measure human performance and carry out astronomical observations; and working exhibits and mini-computers visitors can use to test themselves...
>
> The Creighton Fault, an ancient geological fracture, runs through the building and has been left untouched for visitors to see...This is probably the only building built over a fault...The rock is among the oldest that can be seen on the surface of the earth...(Illust. #17)

Science North is another of Raymond Moriyama's buildings. Science North also operates the Big Nickel Mine, some 3 km west of the 'snowflake' building. It features tours in a replica mine rescue rail car of a type used throughout North America in the 1920's and 1930's, as well as a demonstration of mining and mining equipment.

The April/May 1991 issue of the Geographic included an article by Ken Sobol and Julie Macfie Sobol on Home-Grown Museums. These have been set up by individuals, rather than corporations, associations or governments, and there are a whole lot of them across Canada. In this article, the authors have suggested that these individuals are obsessive accumulators who have an equally powerful impulse to grab people by the scruff of the neck, hold them up in front of their collections, and shake them until they understand just what is so fascinating and important about what they are seeing!

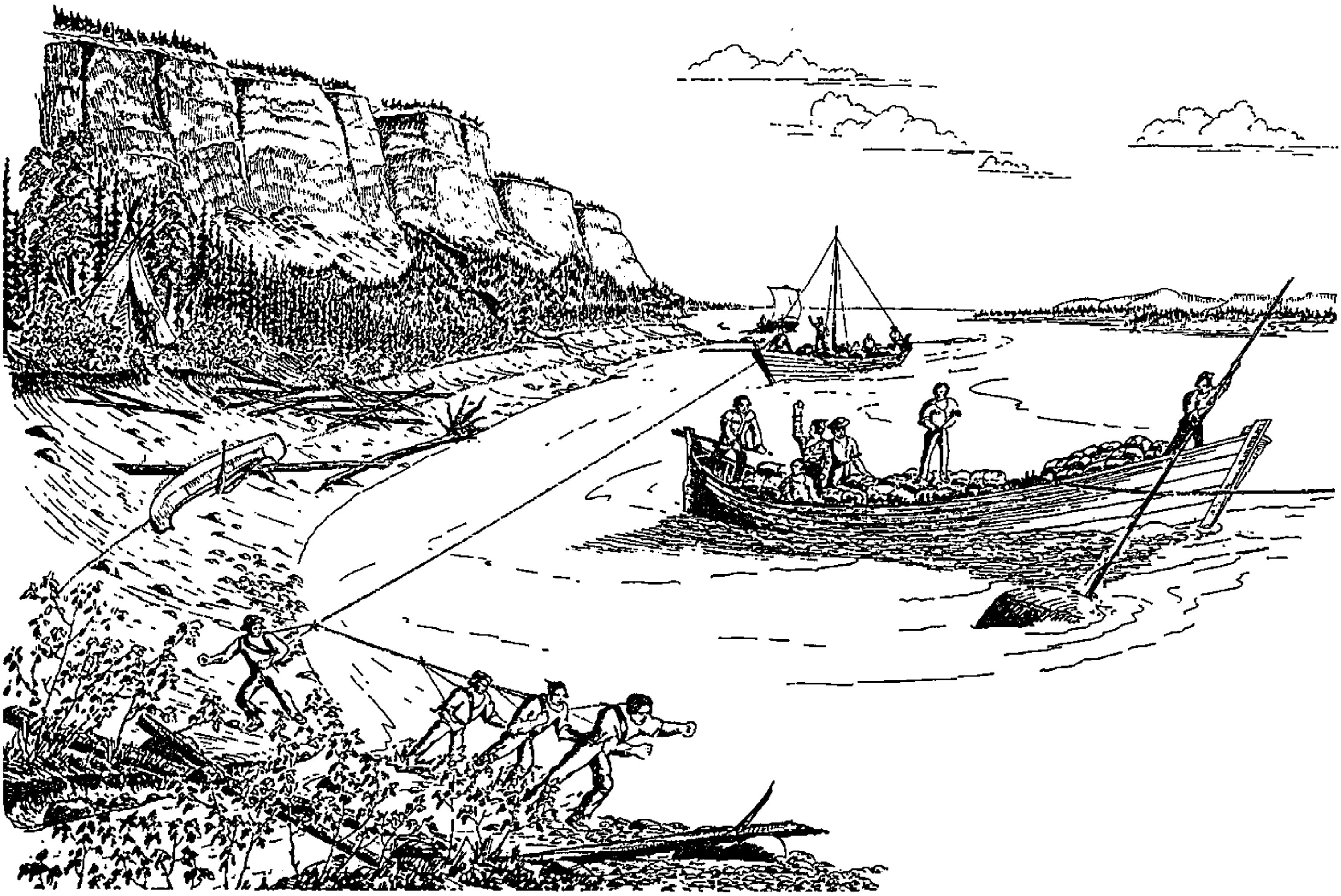
The home-grown museum creators are often looked down upon by those in the world of professional museums which - the authors again suggest - is a pity because the best of the private collections provide an immediate immersion in history that few academically-correct displays in the public museums can match. Some of the amateurs have given their museums names, such as: The Century Agricultural Centre; The Pig Museum; The Gervais Auditorium; The Old Strathcona Model and Toy Museum; and The Piano Keep Museum. Some charge admission, and some have a small store to help recover their costs.

As the Sobols have noted, the home-grown museums in Western Canada contain artifacts that are usually less than 100 years old, represent the pioneering days of their grandparents, and include household implements and farm machinery. In Eastern and Central Canada, on the other hand, the museums tend to have a narrower focus - for example: oil lamps, cowbells, stationary engines, hores-drawn vehicles, antique wrenches, duck decoys and magic lanterns. For Pearl Jamieson of Moosomin, Saskatchewan, her particular treasure is one of two Anglican Churches on her lawn. Also, farmers tend to create agricultural museums, shoemakers shoe museums, and dentists dental museums. (Illust. #18)

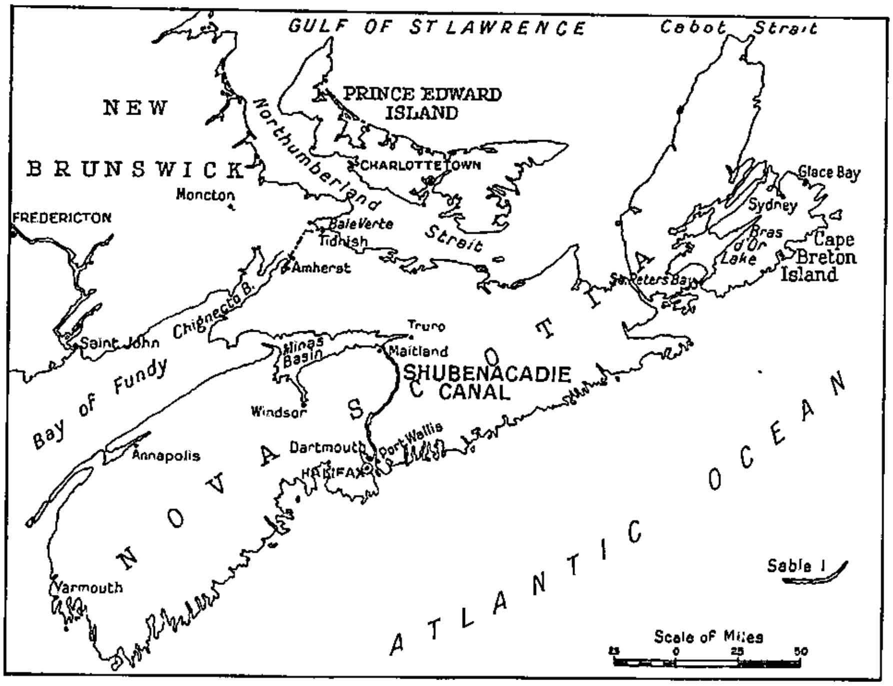
And, as the authors have written:

> There are many more private museums than one might think. Besides Pearl Jamieson's, we know of 27 other private museums in Saskatchewan alone, and there are undoubtedly dozens more we have missed. Across the country there are hundreds in living rooms, basements, garages, sheds, front yards, back yards, bungalows, mansions and office buildings...Many actually live in their museums, so a visit to their collection means you are paying a personal call as well...

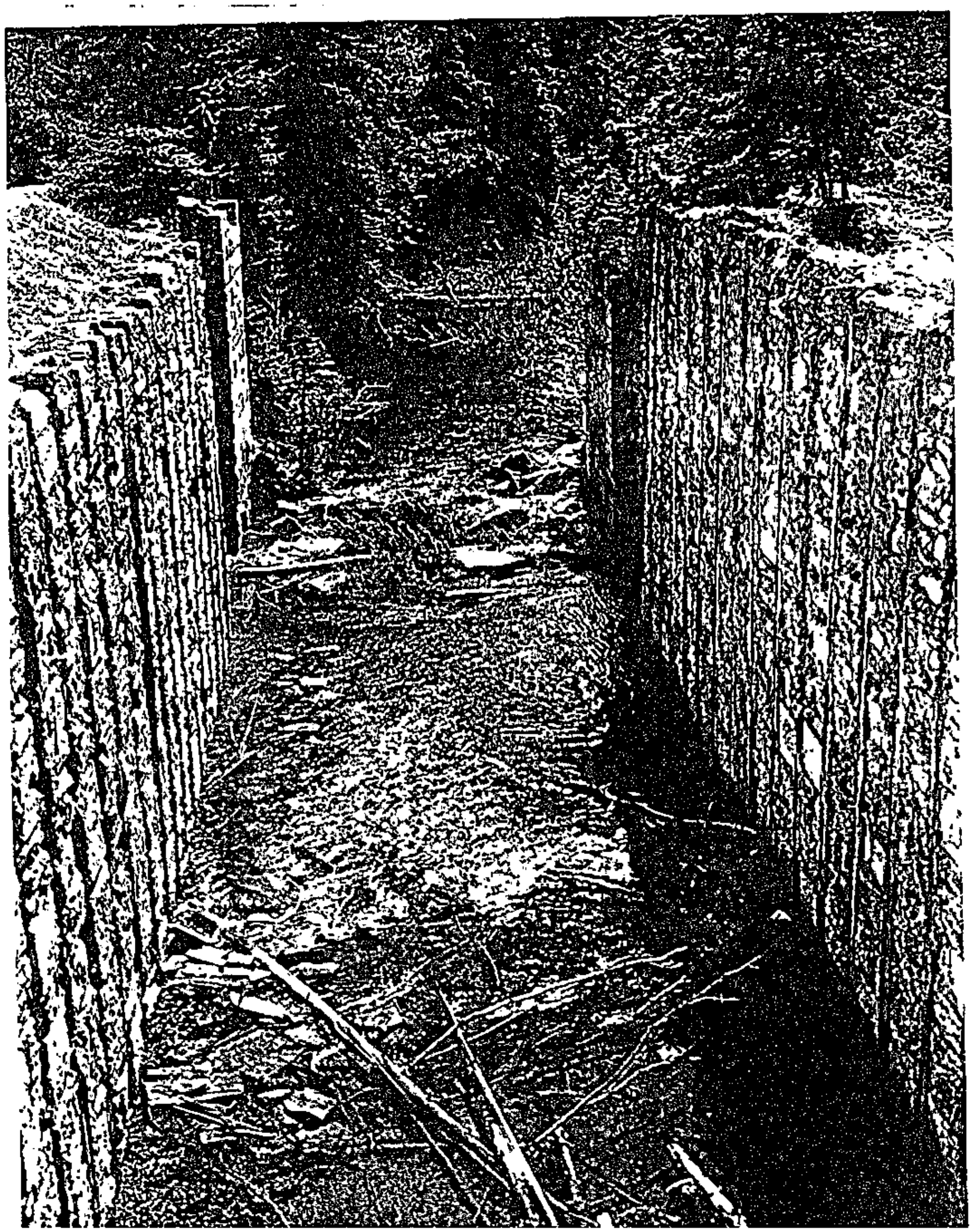
*****



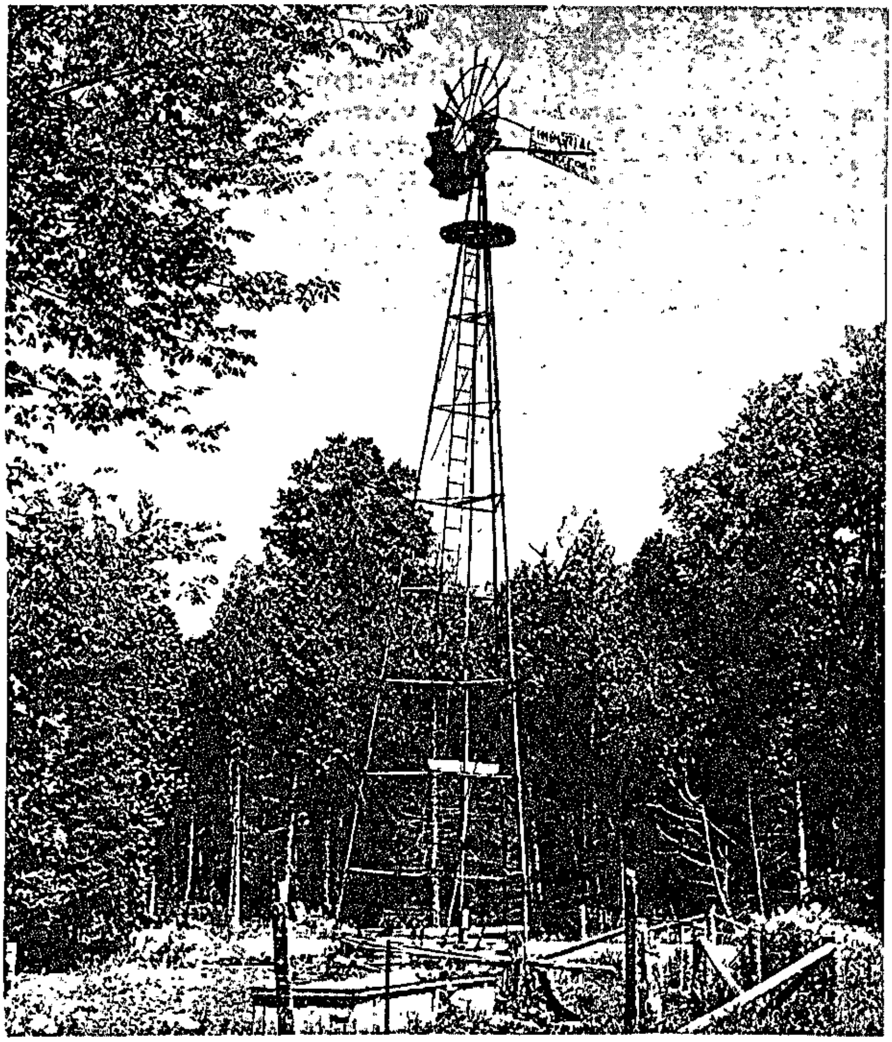
Illust. #1: York boats being hauled up swift water (page 4)



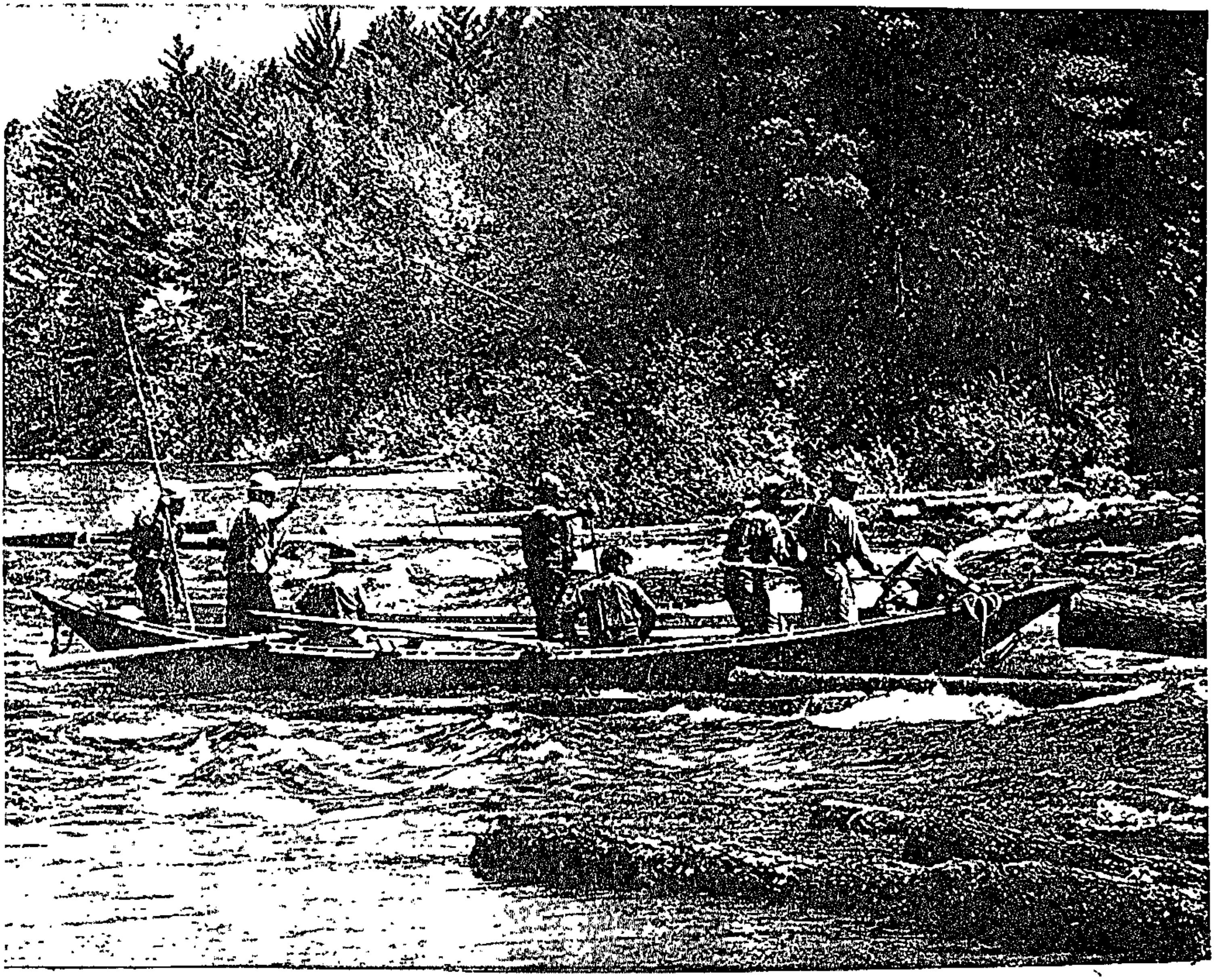
Illust. #2A: Route of the Shubenacadie Canal (page 6)



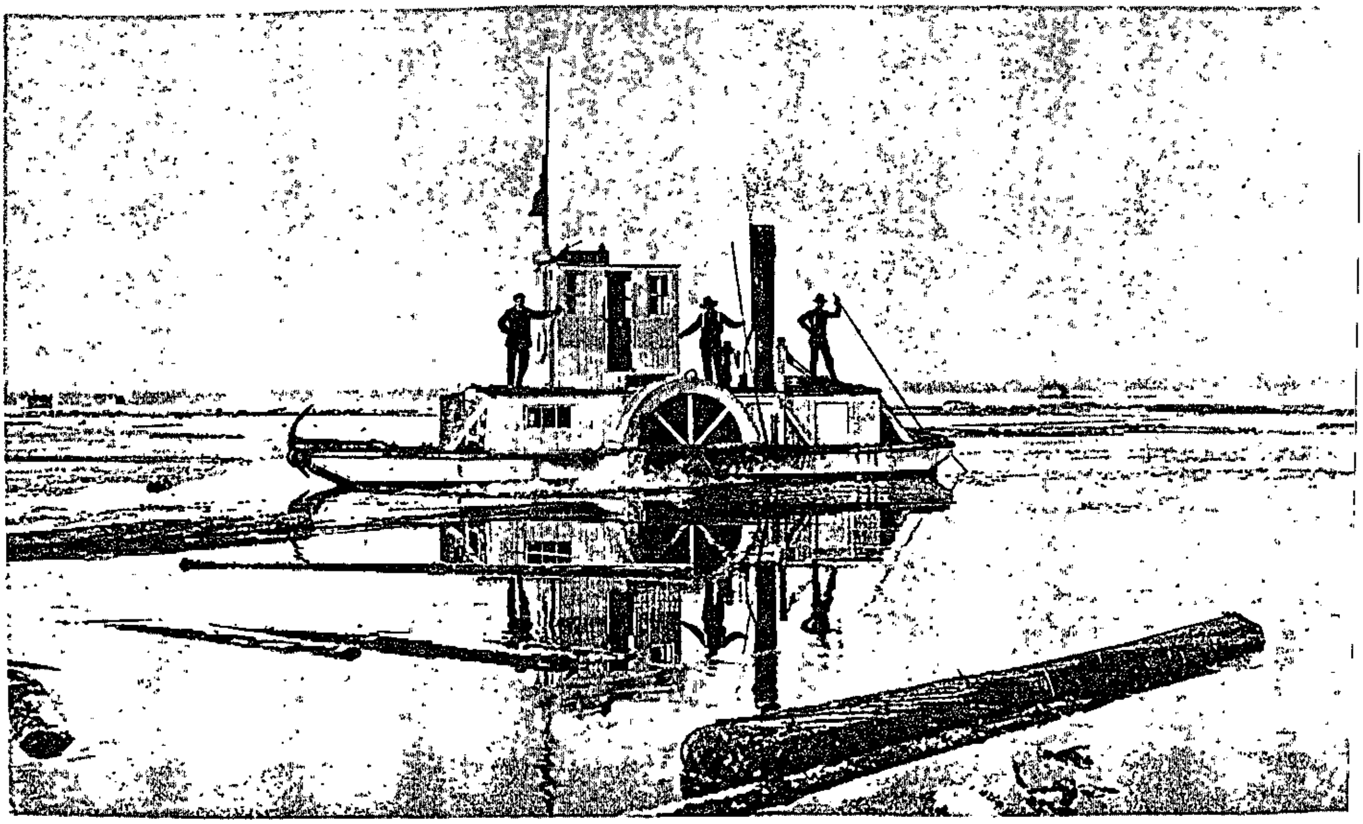
Illust. #2B: Remains of one of the Shubenacadie Canal locks, at Port Wallis (Page 6)



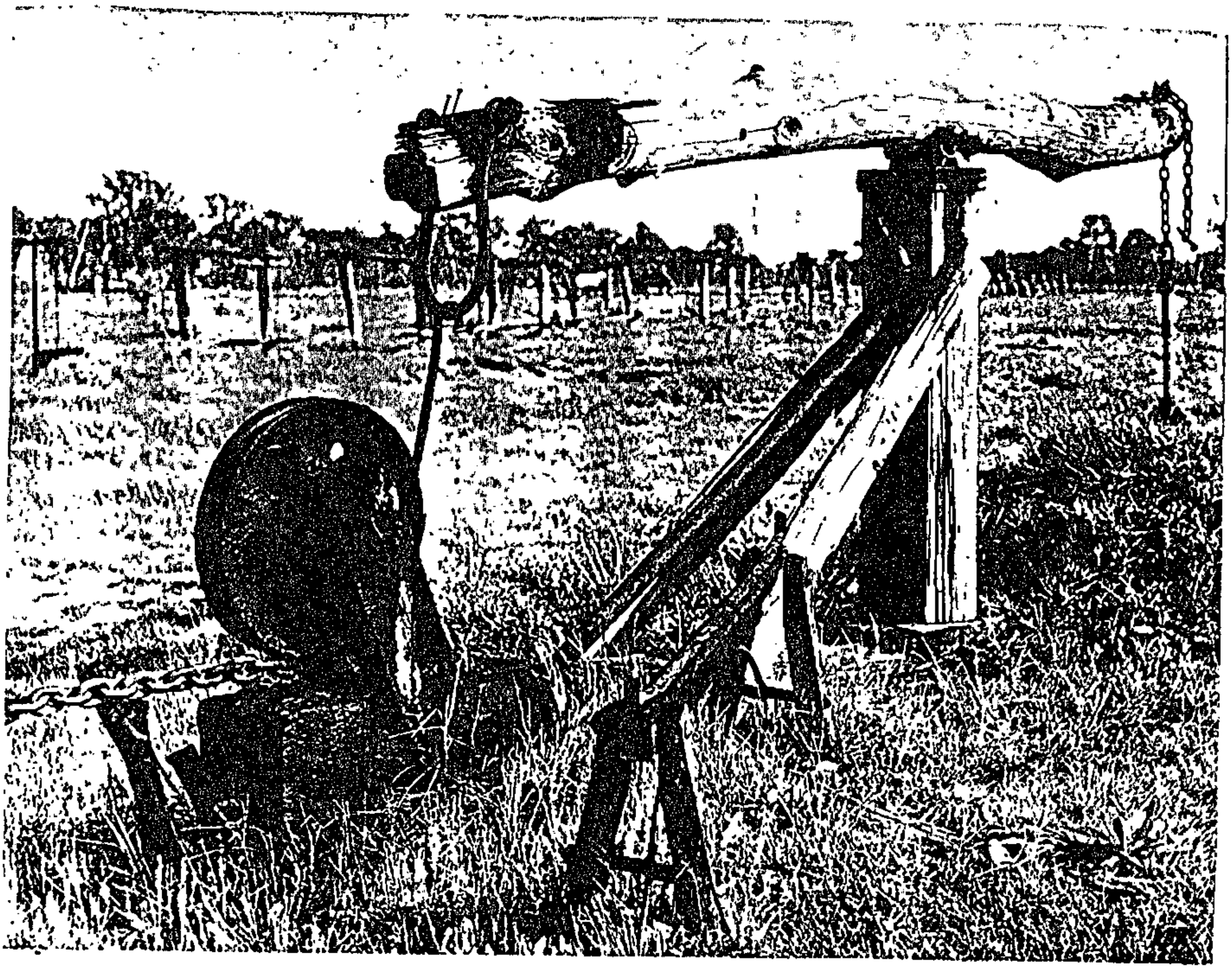
Illust. #3:
Windmill that once drained
a cattle trough;
now derelict
(page 7)



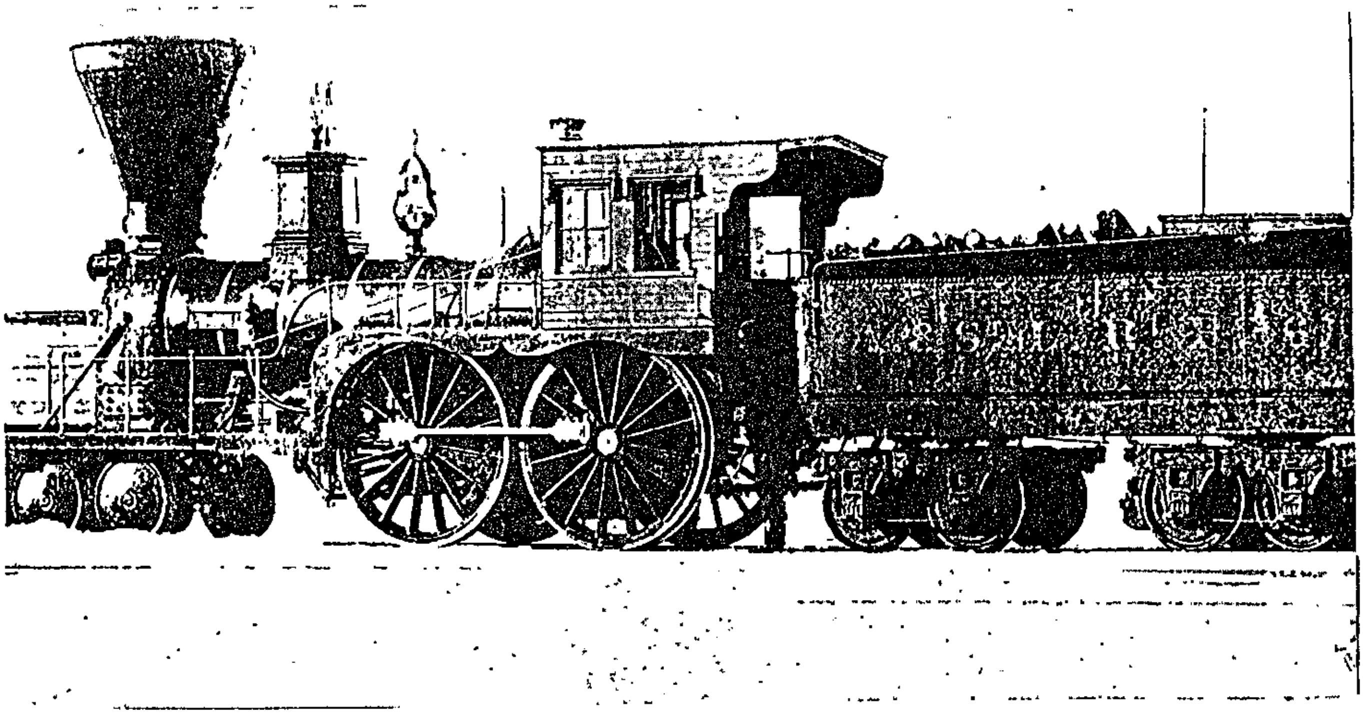
Illust. #4:
Pointer boat among floating logs
on the Petawawa River, Ontario
(page 8)



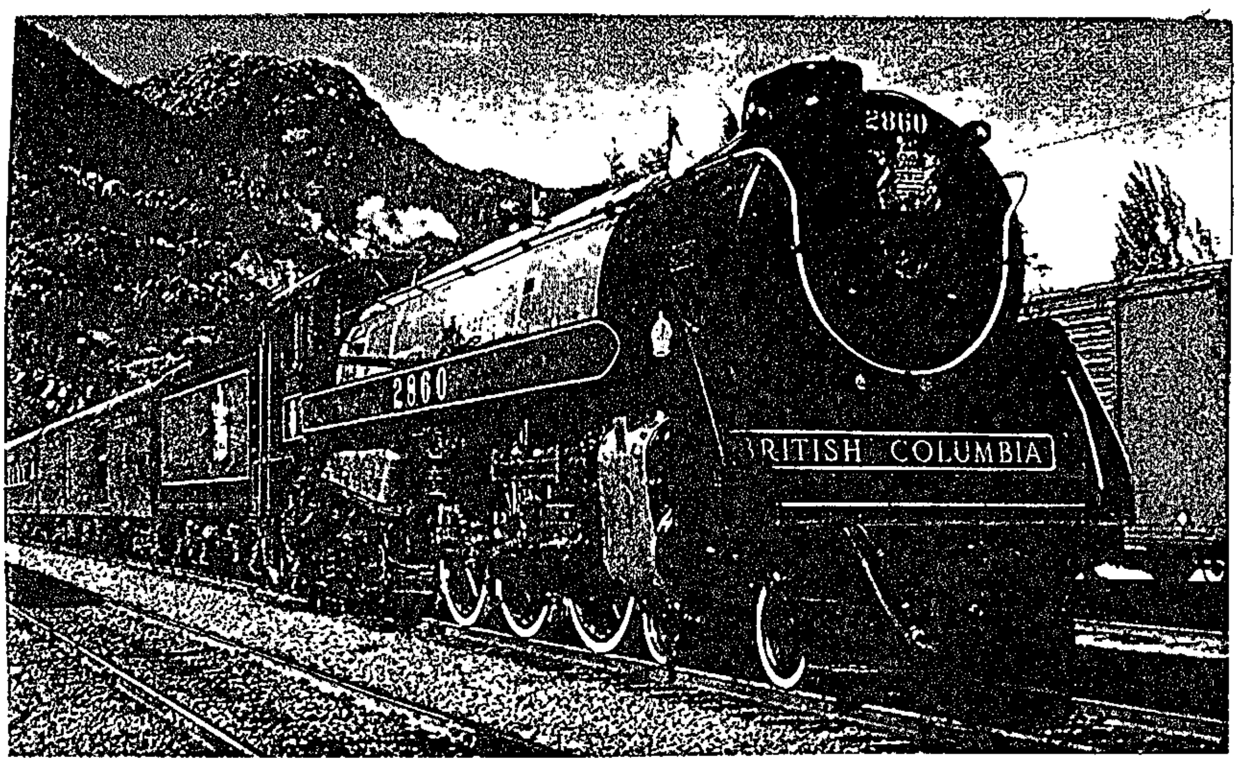
Illust. #5:
Alligator warping tug
at Arnprior, Ontario, August 1908
(page 8)



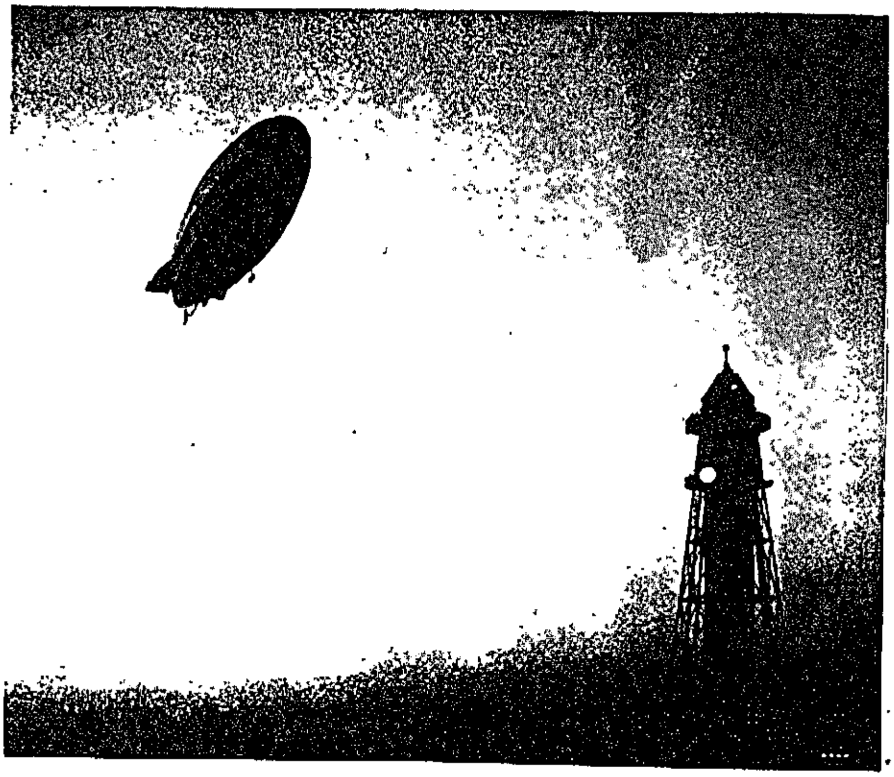
Illust. #6:
Oil well pump made mostly of wood,
attached to jerker line;
early southwestern Ontario oilfield
(page 10)



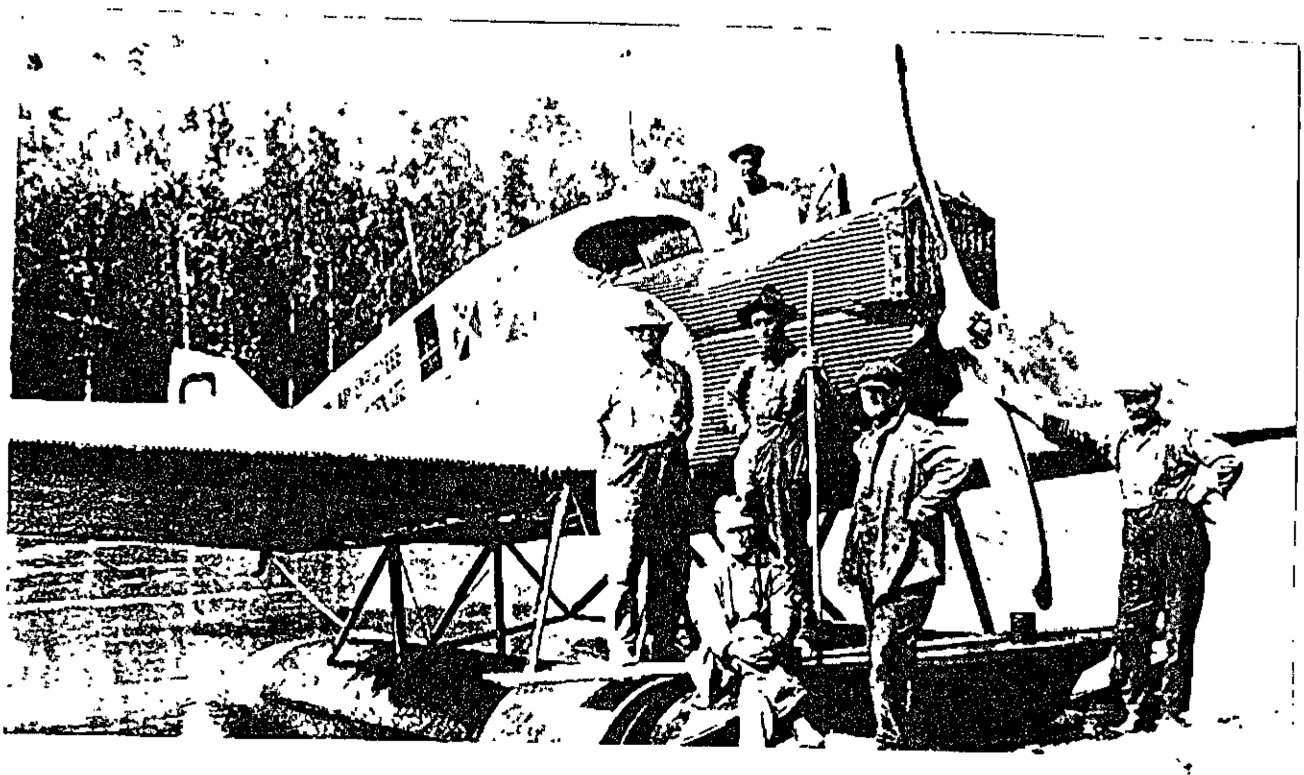
Illust. #7: Locomotive No 6 of the Atlantic & St Lawrence Railway, in 1856 (page 11)



Illust. # 8: No 2860 - One of the last of the CPR Royal Hudsons (page 12)

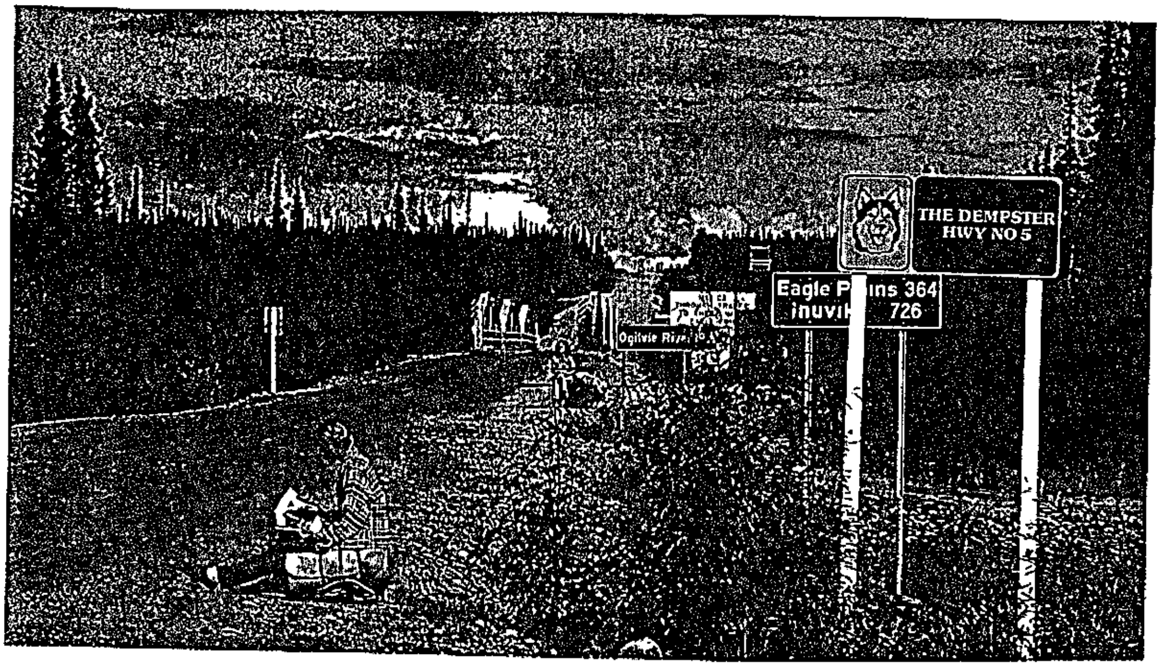


Illust #9: The R-100 arrives at St Hubert, daybreak, 1 August 1930 (page 14)

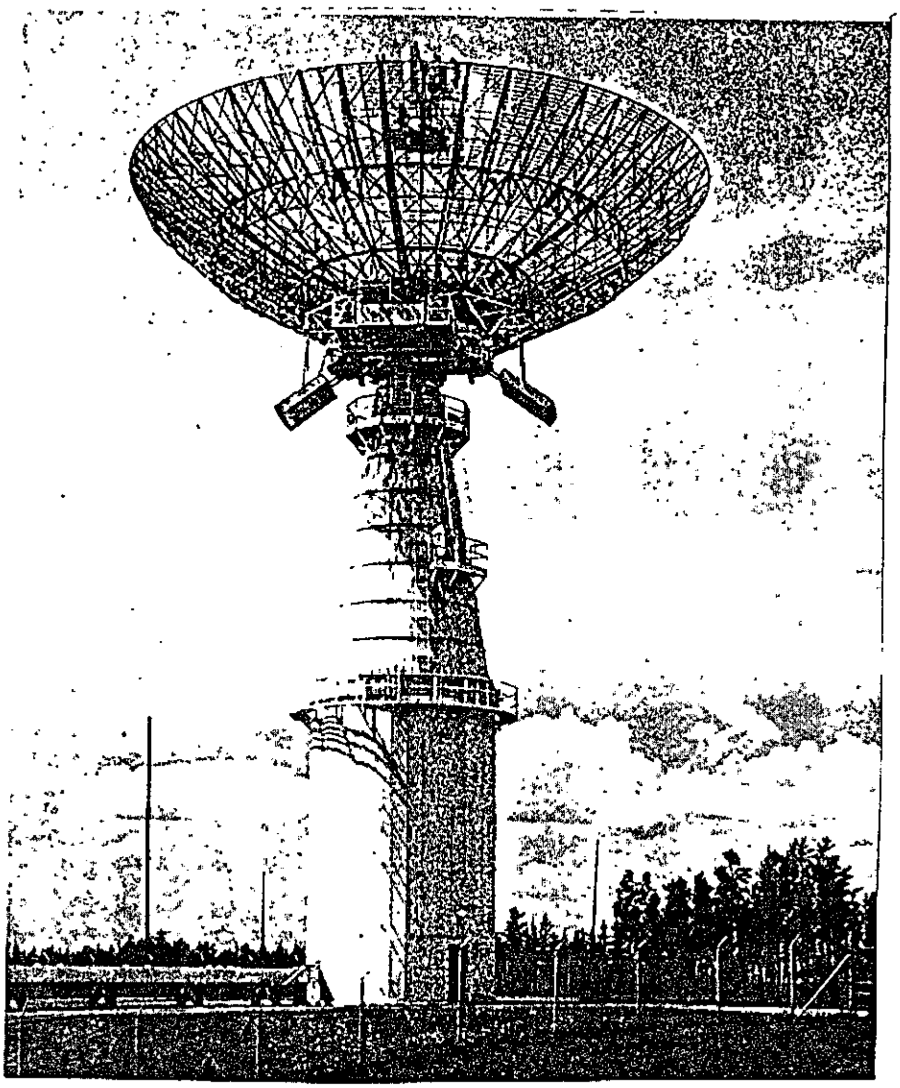


Illust. #10: The 'Hazelton' at anchor on the Skeena River; with members of the Railway Employees Association (page 14)

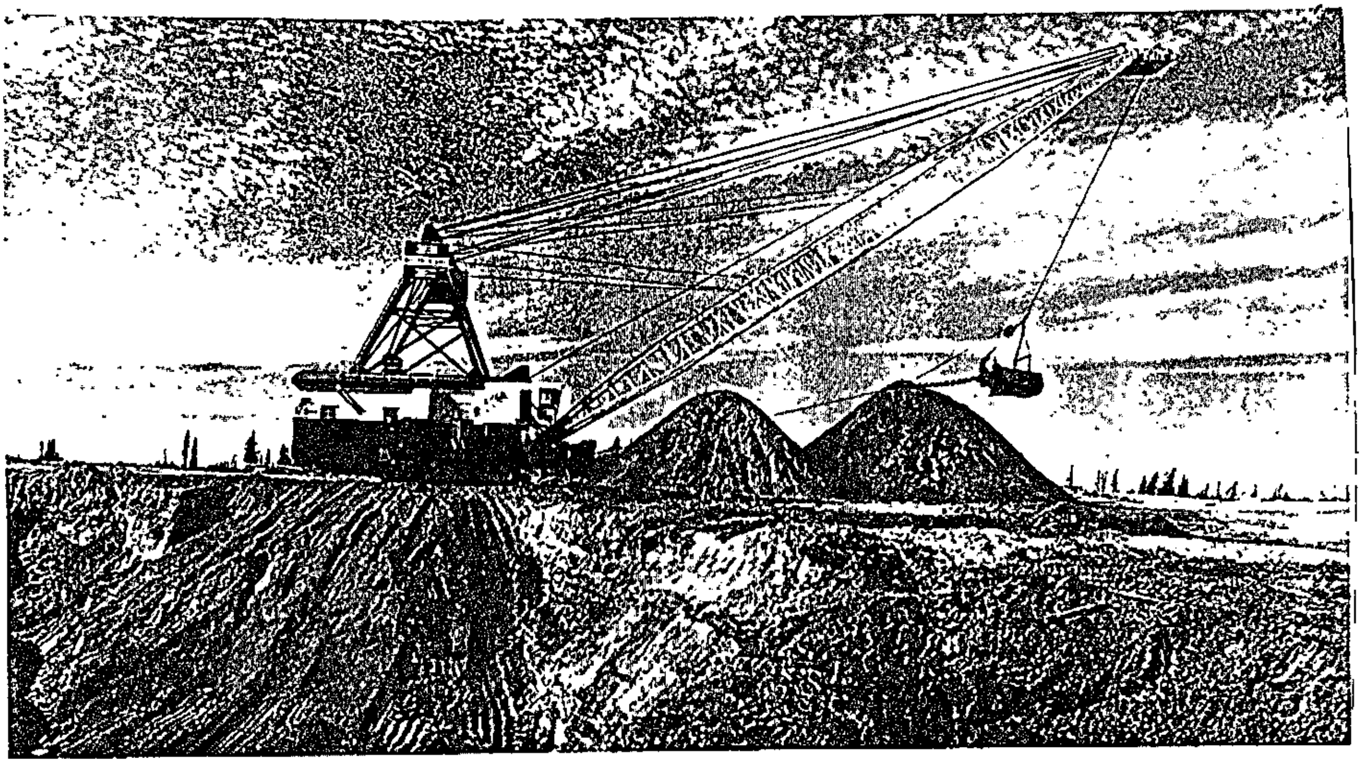
Illust. #11: Curtiss HS2L 'La Vigilance' - owned by Laurentide Air Services Ltd - crashes in remote Northern Ontario Lake, in 1922 (page 15)



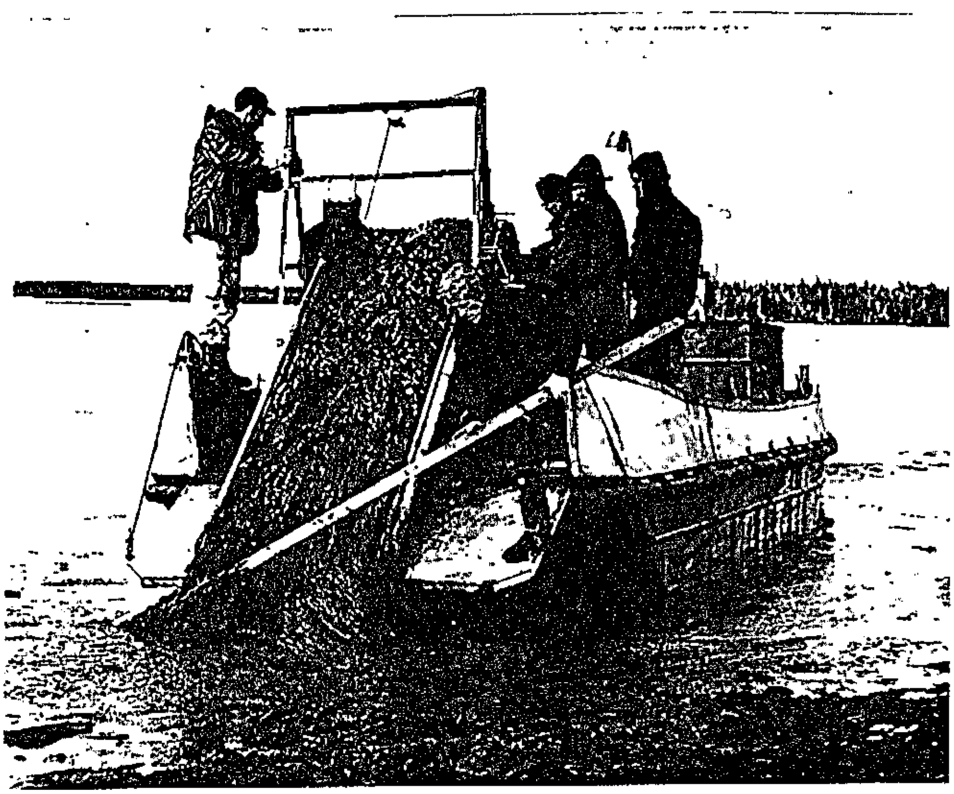
Illust. #12: The start of the Dempster Highway, near Dawson, Yukon Territory (page 19)



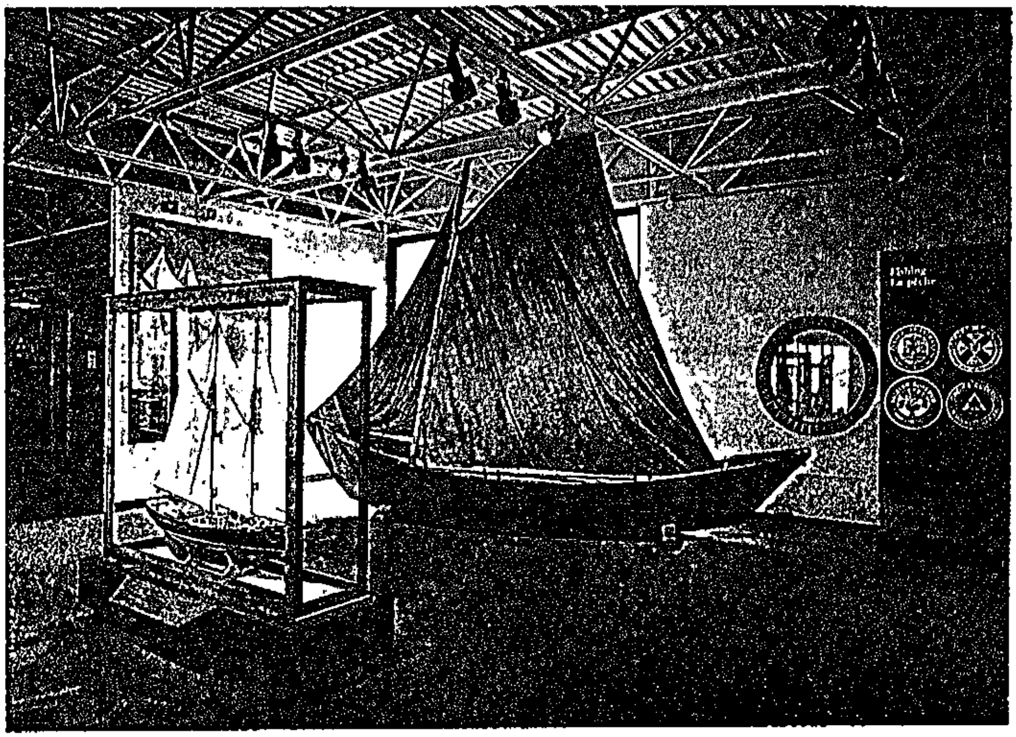
Illust. #13: Satellite receiving station, Prince Albert, Saskatchewan (page 20)



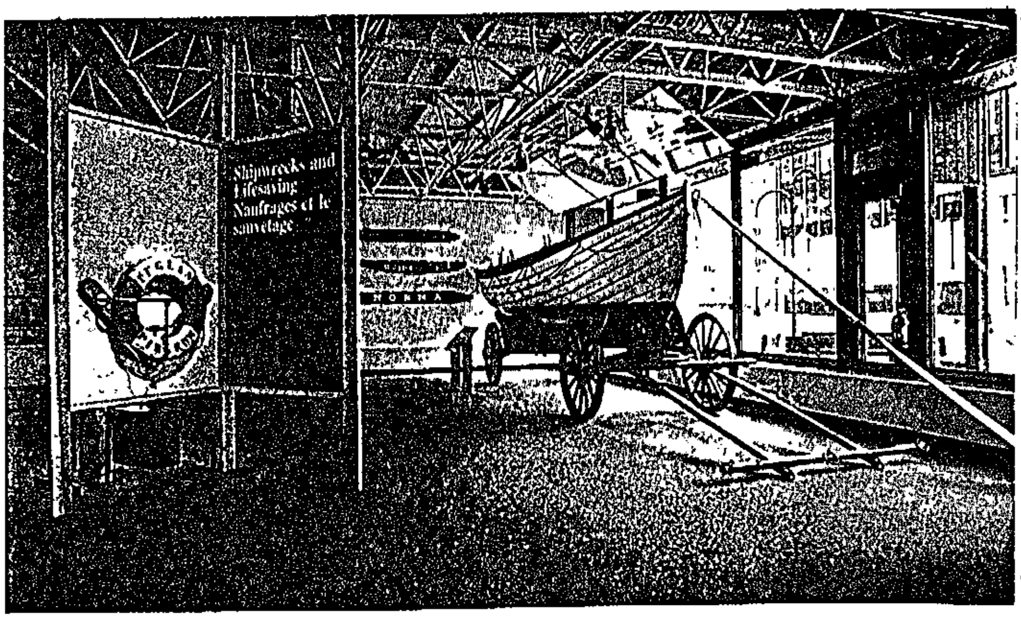
Illust. #14: Syncrude test dragline at Fort McMurray (page 23)

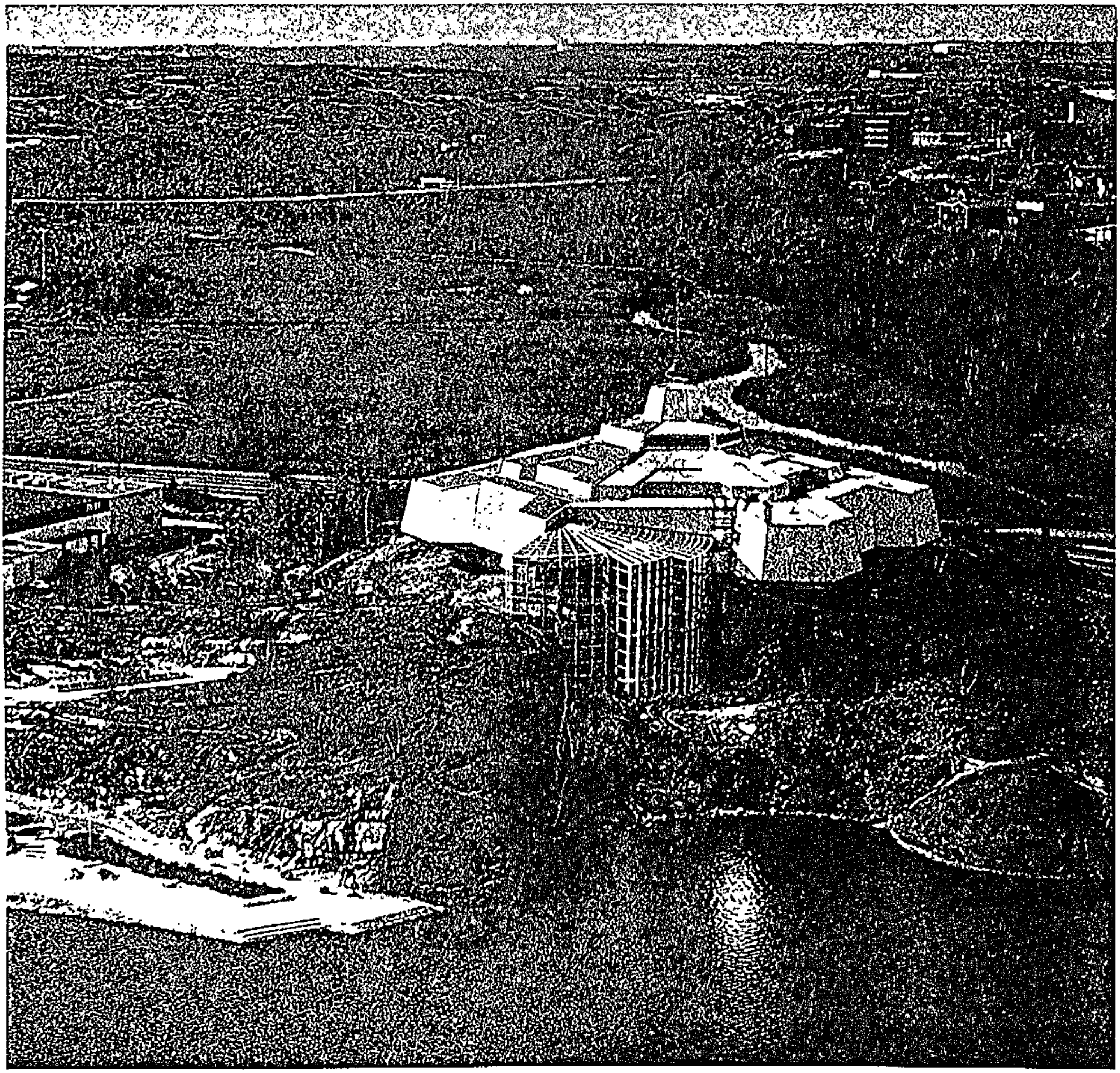


Illust. #15: Slick licker, Operation Oil (page 26)

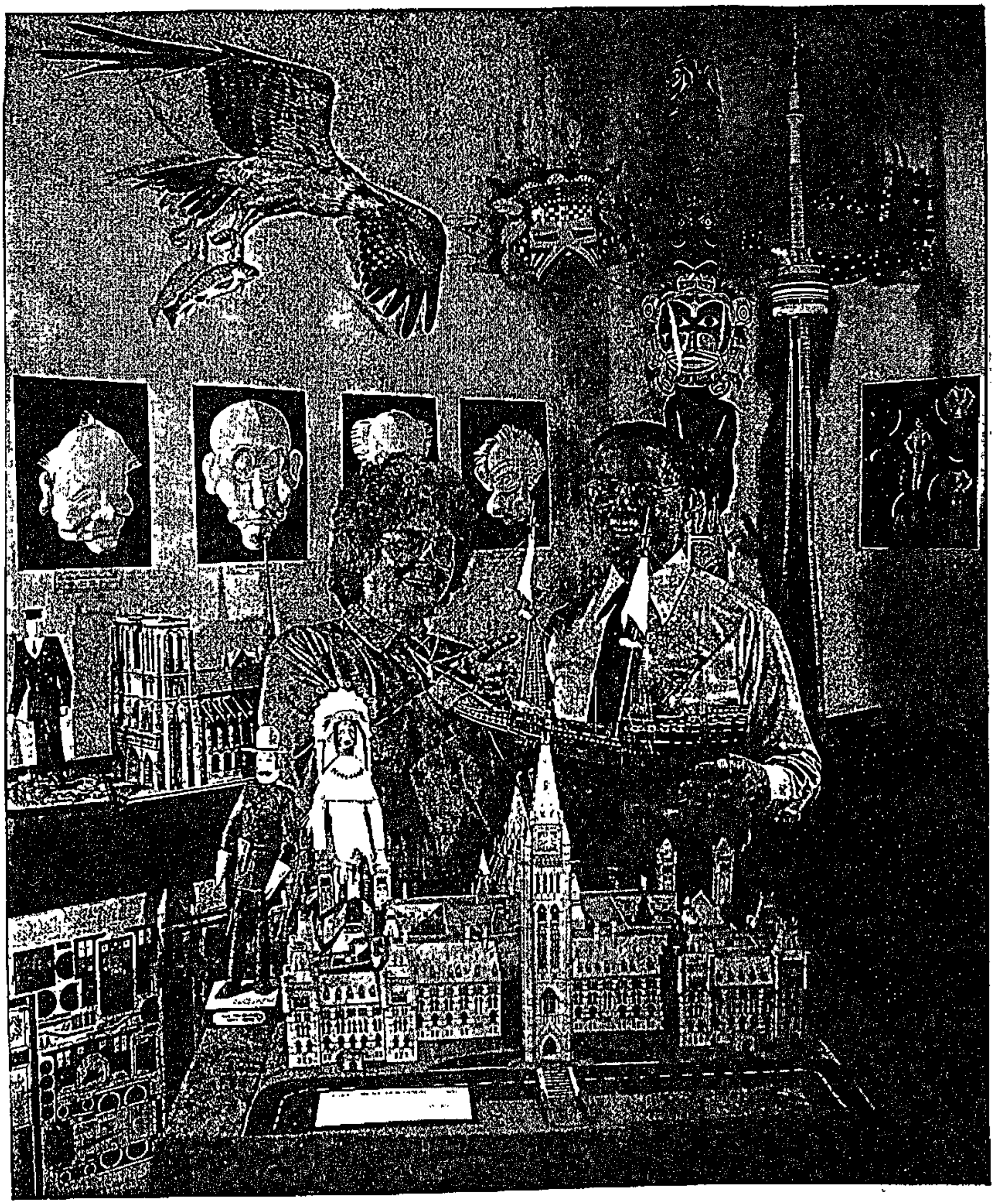


Illust. #16: Maritime Museum of the Atlantic, Halifax
(page 38)





Illust. #17: Science North, Sudbury, Ontario (page 39)



Illust. #18: Paper models in the Old Strathcona Model and Toy Museum, Edmonton, owned by Gerry and George Bell (page 40)