"It has required a great deal of time, effort and money to bring what once was considered a worthless metal to its present status."

"The history of Sudbury is the history of nearly all mining districts. Mines were discovered, smelters built and venturesome pioneers risked and lost their money producing a product which, when it was ready for sale, had to be offered to an almost nonexistent market."

"Inco is not in the business of making ghost towns. It is in the business of operating a continuing business. From a local point of view, and from a national point of view, it is essential that mines be conserved over a long, regular period."

"Technical progress comes from many men, each working on some subject dear to his heart dictated by scientific zeal or by the demands of some commercial problem. By the sowing of the seed of accurate technical information to the largest possible number of scientific and technical workers, many a new idea is born or wished-for result achieved."

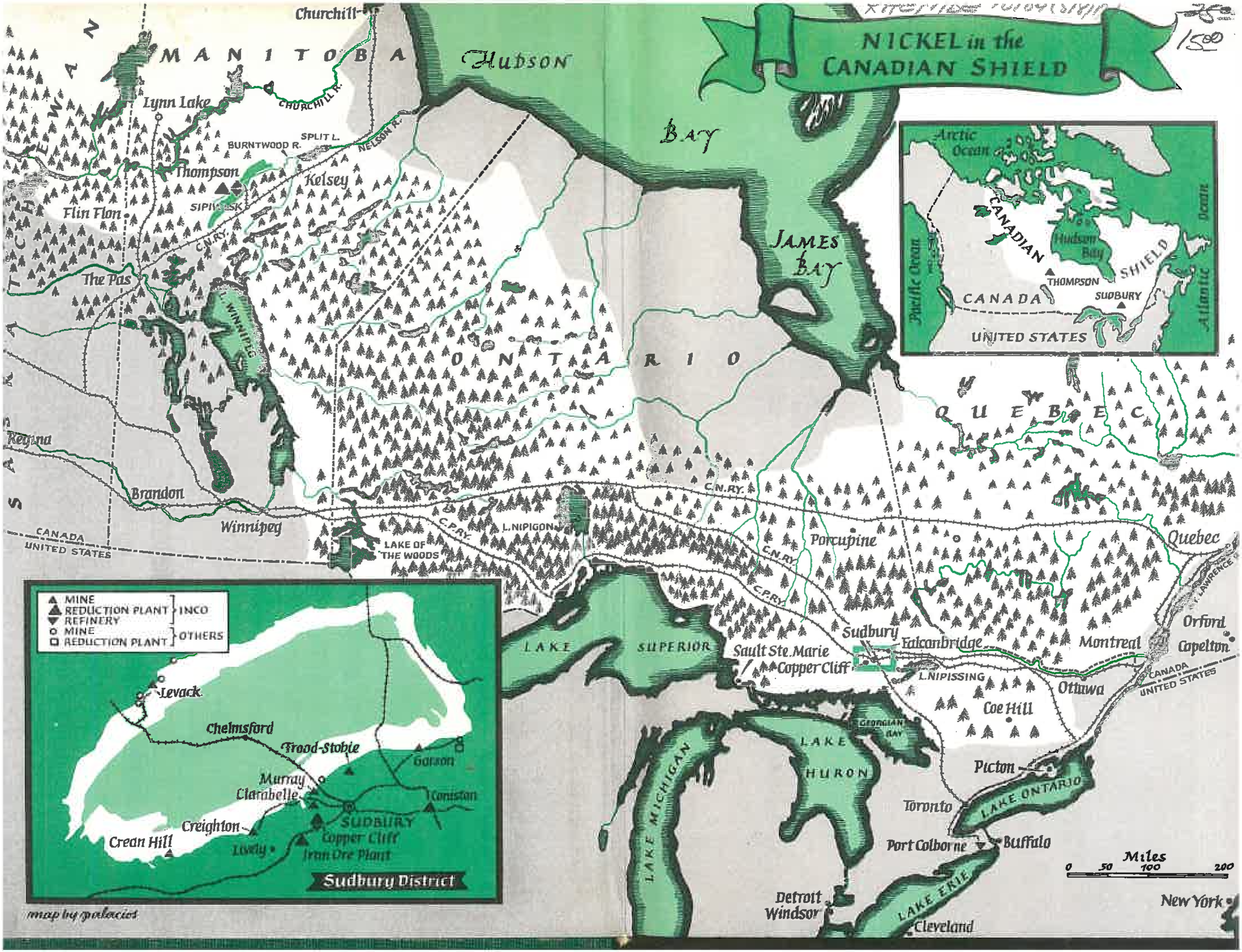
"It is the obligation of the individual to stand on his own feet, make his own decisions and take the responsibility for these decisions. He should carry his own troubles and, if strong enough, help other people to carry theirs."

"When you need help you will hire an assistant, or assistants. With a vital interest in the success of the immediate job, you will try to find men who are more competent than you are. Sooner or later, having such men, you will not be needed in that department. The men you hired will push you out—into a larger, and better, job."

FOR THE YEARS TO COME

A Story of INTERNATIONAL NICKEL of CANADA

JOHN F. THOMPSON AND NORMAN BEASLEY



NICKEL in the CANADIAN SHIELD
MANITOBA
Churchill
Hudson Bay
Lynn Lake
Churchill R.
Burntwood R.
Split L.
Nelson R.
Thompson
Kelsey
Sipiwesk
Flin Flon
C.N.RY.
The Pas
L. Winnipeg
James Bay
ONTARIO
QUEBEC
Regina
Brandon
Winnipeg
Canada
United States
Lake of the Woods
C.P.RY.
L. Nipigon
Porcupine
Quebec
Lake Superior
Sault Ste. Marie
Copper Cliff
Sudbury
Falconbridge
L. Nipissing
Montreal
Orford
Capelton
Ottawa
Coe Hill
St. Lawrence R.
Georgian Bay
Lake Huron
Lake Michigan
Picton
Lake Ontario
Toronto
Port Colborne
Buffalo
Lake Erie
Detroit
Windsor
Cleveland
New York
Miles
0 50 100 200
Arctic Ocean
Canadian Shield
Hudson Bay
Pacific Ocean
Atlantic Ocean
Thompson
Sudbury
Canada
United States
MINE
REDUCTION PLANT
REFINERY
INCO
MINE
REDUCTION PLANT
OTHERS
Levack
Chelmsford
Frood-Stobie
Garson
Murray
Clarabelle
Coniston
Sudbury
Creighton
Crean Hill
Lively
Copper Cliff
Iron Ore Plant
Sudbury District
map by palacios

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MANUFACTURED IN THE UNITED STATES OF AMERICA

Foreword

IN the preparation of a book where one of the writers is a participant in the events and the other is a reporter, a stockpile of unrehearsed conversations is a natural result. In this case, the participant was born in Maine and became the Chairman and Chief Officer of The International Nickel Company of Canada, Limited; the reporter was born in Detroit where he was a newspaperman for a dozen years.

Most of the conversation is about the company and its people; the rest is of governments and changing times, of labor unions, of progress in a large company, of Unitarianism, education and responsibilities, of summers in Maine and winters in Brooklyn, recollections, trivialities — recorded exchanges between two people talking on many subjects, and of many things.

None was included in the reporter's story of many of the happenings in Inco's beginnings and growth because none really belonged there. Yet, certain conversations cannot be left out.

Found in them is the portrait of a man, and an insight into the man, who has devoted more than fifty years to the building of an industry, and to the building of a company. Threaded through this work are Dr. Thompson's recollections of events as they took place. These recollections are used in preamble form as leads to appropriate chapters, and are identified by the initials so familiar to Inco people wherever they may be. The initials are j. f. t.

The recorded conversations themselves comprise the chapter that closes the book.

NORMAN BEASLEY

Contents

Introduction

The International Nickel Company of Canada, Limited, is a combination of two things — important nickel deposits, plus a state of mind.

By "state of mind" is meant the belief that an ore deposit is of no value unless someone finds a way to work it, and to sell his work, profitably and successfully. It also means that excepting as we place limitations upon ourselves by lack of imagination, or by an unwillingness to really work, there are no physical limits to the possibilities of the market for nickel.

In the early days of the company, Ambrose Monell, the first president of the company, went to Sudbury with an associate. Standing by the Creighton open pit, about all they heard was talk of the enormous amount of nickel in the district, and so enthusiastic were the estimates that, tugging at Monell's coat sleeve, the associate said: "Well, Andy, all we need now is customers."

This situation of needing customers is one that has recurred through the entire history of the nickel business. It occurred in 1880, when world consumption was less than 1,000 tons; it was true in 1921, when world consumption was about 10,000 tons; it was true in 1958 when free world consumption dropped to about 160,000 tons from approximately 207,500 tons in 1957. It will be true again.

Our attitude always has been that sufficient nickel resources can be discovered to supply the world's needs and that there can be created enough nickel business for all the nickel the world will produce — and everyone should work for his share as hard as we work for our share. The very effort of working for our share is what keeps — and will keep — the company from settling down at any level.

JOHN FAIRFIELD THOMPSON

1

One of the Great Events

ON foot in unfriendly surroundings, man's earliest mining was a search for stones that could be converted into weapons and tools. He found flint, obsidian, quartz and other stones on the ground and, with them, he found "shining stones." Making no distinction, he lumped them all together in a common stockpile of raw materials.

Unnoticed for a long time was the presence in the "shining stones" of properties not possessed by the others. Much, much later — thousands of years, almost certainly — came the discovery that metal could be melted out of the rock. And so began the unfoldment of metallurgy. Where? Perhaps in Asia, perhaps in Europe, perhaps in Africa. But wherever it was, it was one of the great events of evolution, for it is still changing the world.

It was new knowledge that concerned not gold which, probably, was the metal first discovered, but copper.

Appearing in the form of nuggets, or in small particles of almost pure metal, gold was recovered by washing, or panning. These were ways that were on the doorstep of metallurgy, but only on the doorstep. The disciplines of metallurgy began with the smelting of copper ores for the production of that metal. Some have guessed the event as taking place between 4000 B.C. and 3500 B.C.

Once copper was shaped into usefulness, curiosity led to experiments with other stones, and the discovery of other metals — iron, lead, mercury, silver. It was knowledge that was not passed around freely. One smith initiated a second, and a second initiated a third until, in time, smiths were scattered over three continents. The magic of their blowpipes, their fans, and their charcoal fires brought them places of honor next to tribal chiefs.

Treating iron ores was a different problem than working with copper; also, it was a much more difficult problem. It is reasonable to assume that in experimenting with iron ore the ancient smiths tried the same process that produced metal from copper ores. Iron ores did not respond to that sort of treatment.

Many centuries must have passed before the smiths learned that to attain the toughness and hardness that made it useful, iron had to be reduced from its ore and then heated, hammered, and reheated, and rehammered — over and over again. Many additional centuries must have elapsed before the intricacies of furnace operations and the chemistry of ironworking began to be understood.

In ancient China, an alloy principally of copper and nickel with zinc was a familiar article of commerce. It was an alloy called paitung which was used in the manufacture

of a profusion of small articles such as candlesticks, teapots, incense basins, water pipes, etc. Often called "white copper," paitung was a malleable metal of great durability and versatility.

Trade in metals was from hand to hand, and not by caravan. Paitung was delivered to the artisans in round or lentil-shaped cakes about seven inches in diameter; gold, copper, iron and other metals passed from hand to hand in small ingots. The custom was to stamp and weigh the ingots with each transaction. Often the ingots served as money. However, the quantities traded in could not have been large. Most of Africa, all of the Western Hemisphere, all of Australia and New Zealand, much of Russia and a good part of Asia were unknown; in fact, a good part of the *known* world was only vaguely known.

With the arrival of the Christian era stone tools still were in use in Europe; so were stone sickles in Africa; so were bronze axes in Asia. Commerce was moving along the Nile and across the Mediterranean into Asia Minor where galleys and lateen-rigged ships were replaced by camel caravans that plodded across India and into China.

Across the centuries from the sixth century B.C., when the first recorded coins were minted in Lydia, and beyond the sixth century in the Christian era, world trade, in large part, was in barter. China, which probably was the most advanced of all nations in the sixth century A.D., had no general coinage although its commerce had spread over Asia and Europe and deep into Africa.

In small coinage the Chinese did have pieces of perforated brass and, for large coinage, stamped ingots of silver but, as said, no general coinage. The Carthaginians, Romans and Greeks all had metal coins, the smallest being in use in Greece. These were of silver, not much larger than the head of a pin. For safekeeping, Athenians sometimes carried the coins in their mouths.

Before the fifteenth century, galleys and lateen-rigged ships were hugging the shores of the Mediterranean, Adriatic and Aegean seas in quest of trade while other ships were venturing into the Atlantic and spreading sails to find the winds that would bring them to England, Iceland and Norway.

In the fifteenth century, all over Europe men were talking of trade and of new routes to the East. Before the century was over, a penniless Genoese was in command of three caravels, the largest of which was about one hundred tons, and was setting out to find a new way to Cathay. On October 11, 1492, land was sighted. The following day Christopher Columbus reached the shores of the new world.

The discovery of America was not a single act but the work of two centuries and more, by men such as Cartier, LaSalle, Alvarez and Bering — and, as with the Western Hemisphere, so was the discovery of nickel not a single act. Identified by the Swedish scientist Cronstedt in 1751, and named by him in 1754, it was not until the twentieth century that men began finding in the metal qualities that men before them had not suspected.

The history of nickel reaches from antiquity and, while so doing, divides itself into three stages. The first stage ended in 1751. This was the stage of nonrecognition. The second stage lasted approximately one hundred and fifty years, or from 1751 until the twentieth century. This was the stage of limited use. The third stage is under way. It is one of unlimited use. It will last as long as there are inquiring minds.

The third stage began when the element was examined

from the vantage point of "What can be done with this material?" Under these auspices, it became the first metal to be studied in an orderly, deliberate way with, to repeat, the thought in mind of "What can be done with this material?" — rather than from the level of a curiosity more interested in what it was than in what it could do.

2

The Diary of the Shield

EARLY in 1848, Sir William Logan, Provincial Land Surveyor, and his assistant, Alexander Murray, spent a number of weeks examining the terrain adjacent to the Bruce copper mines on the north shore of Lake Huron. Much impressed, Logan instructed Murray to survey the coast farther to the east; and, it may be surmised, to give special attention to six mining blocks — in all, 2,000 acres — that had been taken up in 1848, but not patented,* by the Upper Canada Mining Company.

The property was a short distance west of the point where Whitefish River empties into Lake Huron. Here Murray found an abandoned promise.

Close to the shore, among the quartzose and chloritic

*Patents were obtained March 4, 1864, the survey having been made in 1848 by Alexander Vidal, P.L.S.

rocks, was a deserted shaft and in the surface outcrop, channels had been marked and cut. Now shaft and channels were filled with water, and debris littered the surface of the water. Murray was not able to make a satisfactory examination of the property, but he did notice copper pyrites in company with other minerals. Selecting a specimen the surveyor brought it back to Ottawa for official analysis by T. S. Hunt, Chemist and Mineralogist to the Geological Survey; and learned that "in the process of dressing the ore, the earthy parts being removed by washing, the composition of the ore in 100 parts, as deduced by calculation, would be:

"Iron	41.79
Nickel / Cobalt	13.93
Arsenic	6.02
Sulphur	38.16
Copper	.10
	100.00"

It was a discovery of very great importance because it indicated the presence of nickel in the area, although the mine itself never amounted to anything. However, because of the difficulty in separating nickel from other minerals, and because the uses of nickel were so limited, more than thirty years were to pass before there began to be any measure of understanding of the significance of the event.

Of more interest to the people of Canada in 1848 than the discovery of nickel was the coming of the railroad. Eleven or twelve years before (in 1836 or 1837) efforts to promote the Inter-Colonial Railway, connecting St. Andrews, New Brunswick, and the city of Quebec, collapsed when the United States charged that the right of way crossed disputed territory in the state of Maine.

Undismayed, although the colonial government of New Brunswick had persuaded the Imperial Government to give ten thousand pounds for surveys, the people continued to talk of projects that were more ambitious than the stamina of their pocketbooks. Already there was talk of confederation of the four provinces of Nova Scotia, New Brunswick, Quebec and Ontario; and men were speaking of the wide prairies to the west, of silent, high mountain ranges, of the Pacific and, on tiptoe, were heralding a tomorrow when vast solitudes and the four provinces would be one nation, when rails would join the Atlantic and the Pacific* — as now rights of way were being established in the maritime districts of Nova Scotia and New Brunswick.

Largely unexplored, Canada's present approximately 4,000,000 square miles contained less than two million people. For the most part, it was a population that confined itself to the four provinces. Farming, some mining, some lumbering, a small amount of manufacturing, and fishing were the chief means of livelihood. More and more, prospectors and government surveyors were penetrating the wild lands and bringing back evidence of Ontario's great timber and mineral wealth.

Prospectors and surveyors told of reaches of seventy or eighty miles of white pine and yellow birch, spruce and larch — of birch trees three and one-half feet through and growing to a height of seventy to eighty feet; of

*In 1851, in Halifax, Joseph Hart, a printer and one of Nova Scotia's great sons, made this prediction:

"I believe that many in this room will live to hear the whistle of the steam engine in the passes of the Rocky Mountains, and to make the journey from Halifax to the Pacific in five or six days."

maple from twenty-four inches to thirty inches in diameter; white ash from fifty to sixty feet high; a sprinkling of whitewood; stands of Norway pine containing trees thirty-six and forty inches in diameter; hardwoods in abundance . . .

Of balsams, elm, cedar and oak, of underbrush shoulder-high and, in many places, so dense that topographical surveys could be made only by following the rivers and lakes through the forests, and estimating the general character of the country from the water's edge. Moss covered wide areas. Sometimes, when scraped aside, it was found to hide rocks intersected by veins containing copper and iron, cobalt, nickel, silver, gold and sulfur. There was evidence of manganese, coal, lead, and other minerals.

In 1855, Joseph Cauchon, Commissioner of Crown Lands, directed A. P. Salter to explore the rivers emptying into Lake Huron eastward from Sault Ste. Marie. In essence, Salter was told, "Ascend these rivers and bring back to us a general description of the tract." Accompanied by Count de Rottermund in the capacity of geologist, Salter traversed the rivers and streams of the territory, reporting principally upon the lay of the land, and its timber resources.

There was one sawmill on the whole length of the north shore of Lake Huron. It was located at Collins Inlet, a dozen or so miles east of the spot where Alexander Murray found nickel in a derelict mine. The sawmill equipment consisted of two upright saws, a circular saw and a siding machine. De Rottermund's report on the geology of the territory was of small value to the Canadian government. Largely it consisted of the "extraordinary theories regarding geological and mineralogical phenomena, which the author entertained."*

Salter was not a geologist, but did report many signs of mineral wealth, and he was "led to hope that at some future period these portions [of the lands explored] would serve to increase the revenue of the country."**

In 1856, Salter was in the district again, this time to make preparations for a general survey of the entire area between Lake Nipissing and Sault Ste. Marie. It was while he was running a meridian line north of Lake Nipissing that he "discovered considerable local attraction, the needle varying from 4 degrees to 14 degrees westerly. The existence of iron was plainly discernable on the rocks." While not a geologist, Salter realized the implications in the needle's oscillations, and reported his suspicions to Alexander Murray who, in 1856, was making geological surveys in the same area.

Following up Salter's suspicions, Murray visited the locality and set down his findings:

> When I came to the part indicated by Mr. Salter, I made a very careful examination not only in the direction of the meridian line, but for a considerable distance on each side of it, and the result of my examination was that the local attraction, which I found exactly as described by Mr. Salter, was owing to the presence of an immense magnetic trap.
>
> The compass was found while traversing these trap ridges, to be deflected from its true bearing up-

*Royal Ontario Nickel Commission. 1917.

**In March 1857, Joseph Cauchon made an exceedingly able report dealing with the future worth to Canada of the lands north of Lake Huron. The commissioner's chief sources of information were the records supplied by Sir William Logan and A. P. Salter.

> wards of ten degrees at several different parts, and in one place it showed a variation of fifteen degrees west of the true meridian, or about twelve degrees from the true magnetic north. . . .
>
> The magnetic trap discovered on Mr. Salter's meridian line north of Whitefish Lake was observed to hold yellow sulphuret of copper occasionally; and Mr. Hunt's analysis of a hand specimen of the rock, weighing ten ounces, gave twenty grains of metalliferous material, of which eleven were magnetic and consisted of magnetic iron ore, with a little titaniferous iron ore, and magnetic iron pyrites containing traces of nickel. The nine grains of non-magnetic mineral consisted of iron pyrites containing from two or three percent of copper, and about one percent of nickel.*

For a second time, the importance of the discovery was disregarded, although "the presence of an immense magnetic heap" was officially reported to and by the government. There were a number of reasons for the lack of interest. The site was thirty or thirty-five miles from navigable Lake Huron. The new lands were almost impenetrable. There was rocky terrain and wooded terrain; there were ridges that rose to quick heights, shallow streams interlacing each other, stretches of marshland; there were no paths into the wilderness, and no paths out. Prospector or surveyor, men found their way by compass.

Nickel sold for more than one dollar and a half a pound — which was many times the price of copper or iron — but its few uses and its difficulty of extraction were sufficient handicaps without including the certainty of

*Geological Survey of Canada, 1853-6, pp. 180, 189.

hardship. Besides, such mining operations as existed were highly uncertain ventures.

They were mining operations that were confined to copper, the leading producer being the Bruce mines. There was copper in quantity, but the absence of smelting facilities in Canada and the cost of shipping the ore to England made mining a doubtful proposition; in fact, almost a sure loser. In the beginning fortunes were made in the Bruce mines, afterwards fortunes were lost. As the veins became pinched, shipping charges cut deeply into the profits, then absorbed all the profits until nothing was left but an exhausted company.

But, whatever the uncertainty of mining itself, there was no doubt of the presence of minerals in quantity. Each year geologists and prospectors ranged to the west, beyond Fort William to the Lake of the Woods; to the north, past Abitibi and to James Bay. In the brooks and streams and lakes they found trout and whitefish; in the forests and marshlands, partridge, ducks, geese, deer, moose, mink, bear, porcupines; below the ridges and on the ridges, berries, chokecherries and wild grapes, a profusion of flowers, trillium, violets, anemone, jack-in-the-pulpit, lady-slippers, cowslips — wherever they went, they lived off the land and examined its diary.

It is a diary whose pages were written before there was life upon the earth, before there were rivers and lakes and seas — when what we now think so substantial was only an incrustation filled with flaming gas and molten rock, and beginning its long pilgrimage around the sun.

The earliest formed crust probably foundered repeatedly but finally became thick enough to be crumpled into mountain ranges when the earth was subjected to gigantic stresses. The roots of the mountains were invaded

by molten rock from which all kinds of mineral deposits were born.

The wearing down of the mountains by disintegration and erosion over eons of time has placed these deposits at or near the present surface. This history of events involving the Canadian Shield had long been known to geologists but its widespread distribution, geographically, had not been realized.

Underlain by a mass of ancient crystalline rocks, mostly granite, the Shield is an enormous horseshoe lying across Canada from Newfoundland to the Yukon, and hiding within its 2,800,000 square miles (including Greenland) wealth beyond human imagination. Here, sealed in the oldest material substance in the world, is the purse of Fortunatus waiting the presence of men willing to pay the high price of pioneering.

In 1845, when Sir William Logan set out to investigate the Shield he confined his studies to the accessible areas of Ontario and Quebec before extending the reconnoiterings to the headwaters of provincial rivers. In the more than one hundred years since, much has been learned about this ancient group of rocks that geologists regard as the foundation of a continent. But more than is known remains to be learned. Much, much more.*

As a whole, the Shield dominates its surroundings. The main drainage lines were established a long time ago. The age of glaciers followed, leaving behind winding ridges of sandy and gravelly drift, mounds of sand and gravel, smoothly rounded hills, valleys, lakes, swamps, low

*"There are many gaps to be filled, and problems to be settled even in the areas most carefully studied, although only a fraction of the Shield has been examined, even in a preliminary way." K. G. Chipman and George Hanson, *Mapping by the Bureau of Geology and Topography*, published by the Canadian Institute of Mining and Metallurgy, 1944.

meadows and fertile fields, long miles of muskeg — all in the distinctive irregularity that marks the present topography. Strewn across the vast Pre-Cambrian formations are islands of greenstone* rich in minerals.

From far to the north and west, close to the Arctic Circle, the Shield swings down and across Canada to the St. Lawrence in the south and east and northerly again to northern Quebec and the Arctic Archipelago. Into it, gold and silver are fused. With gold, silver — and the magic places called Porcupine, Eldorado, Yellowknife, Kirkland Lake, Val d'Or, Flin Flon, Lake of the Woods, Noranda, and Rice Lake come into focus.

In the nickel and copper mines of Sudbury** there is platinum, uranium in the Eldorado, cobalt south of James Bay, titanium in the southeast, thallium in Manitoba, molybdenum in Quebec. . . . When, in 1848, Alexander Murray broke off a specimen of pyrite in an abandoned mine shaft west of the point where the Whitefish River empties into Lake Huron, he turned a key in the lock of the Shield; and, although it was not soon seen, gave to Canada a heritage of incalculable wealth.

In its efforts to persuade its citizens to become interested in the mineral resources awaiting development, the government made payment as easy as possible. The price it put on public lands was one dollar an acre. No proof

*Any of the various basaltic rocks having a dark green color.

**All the important copper-nickel deposits of the Sudbury district are on or near the outer edge of an oval-shaped area about thirty-six miles long and sixteen miles wide. The outer edge of the formation is marked by a rim of hills of varying width—in places as much as two miles. The hills rise to a height of 600 feet, and are composed of igneous rocks which are divided geologically into two roughly concentric bands.

There is an inner band which, for the most part, is covered with trees. At the edges, the band loses its vegetation, and fades into a second, or outer band. This outer band contains scattered patches of rusty gossans which are the weathered outcrops of the nickel-bearing ores that extend far below.

was required that minerals were present, or suspected of being present. All that was needed was an affidavit of two "creditable and distinguished citizens" that the land being purchased was not occupied and no adverse claim was asserted by anyone else.

Payment having been made, patents were issued and ownership passed from the Crown to an individual. The patentee was not required to live on the property or to make improvements.

These generous terms found few takers. In 1860, the Commissioner of Crown Lands reported but sixteen mining companies on the north shore of Lake Huron. In five, no work of any kind had been started; in eight, shallow pits had been dug, and abandoned; in three, there was activity. The three were the Bruce, Wellington and Copper Bay, and Rankin's mines. The search was for copper, not nickel.

In the Commissioner's Report, William Gibbard, public land surveyor, told of progress made at the three mines, and he was especially hopeful of Rankin's mine, saying: "If any mine ought to succeed from the result of a sensible and economic commencement, from the rich ores of the lode, from the position close to the great highway of navigation, and also in the immediate line of the great northern road, this should."

Gibbard was too hopeful. Rankin's mine did not pan out.

3

Window Sills Crowded With Samples

THE expiration, in 1859, of the charter of the Hudson's Bay Company brought anxious days to a people not yet a nation. For more than a year before, and for nearly ten years afterwards, voices were raised in dispute over acquisition of a territory covering half a continent, and the control of its trade. The venturesome urged the adoption of a program of expansion to the north and to the west; the prudent cautioned, as did Edward Ellice:

> It is neither the monopoly, nor the proprietary right of the Company, which is of much importance. The great point is, how to govern the territory . . . if the Province of Canada, not having sufficient work on hand to govern themselves, covet this extension of

> their Dominion, its trade and its administration, nothing is as easy as to acquire it.
>
> For a million sterling, they may buy the fee simple to the whole territory north of forty-nine and between Canada and the Rocky Mountains, the whole trade and establishment of the Hudson's Bay Company, but they must saddle themselves at the same time with the expense, and what is of infinitely more importance, the responsibility of a territory extending over 6,000 miles.*

Publicly, John A. Macdonald, who became Canada's first Prime Minister, was of substantially the same opinion. Arguing before the provincial legislature in April 1859, he maintained that even if England made a gift to Canada of the entire territory "we would have no proper means of supervision over it [because] people would rush into it who, from want of restraint, would grow up into anything but a creditable population."

Privately, Macdonald was moving steadily and deliberately toward his great objective for confederation of all Canada into a single nation. He was wise enough to realize that a great deal of work remained to be done before there was national unity; he was patient enough to proceed slowly toward what he believed was the only safe anchorage for his people.

In addition to the differences in opinion over the future of the Hudson's Bay Company, there was stiff opposition to confederation and a willingness, by many, to carve the immense territory into two, or three, separate nations. There were strong differences as to the selection

*Ellice Papers, National Library of Scotland. Edward Ellice was a British fur trader who had much to do with the merging in 1821 of the Hudson's Bay Company and the North West Company.

of a capital city, if confederation did occur. There were economic problems of magnitude, principal among them being the building of the Grand Trunk Railway, a sprawling system projected to link Ontario in the west with the maritime provinces in the east. Although the railroad was the most important undertaking in the economy of Canada, the building of it was a constant drain upon the provincial treasury; and, consequently, an emotional subject of stature.

But after a while, as Macdonald hoped, every vexing part fell into place.

In Britain, Parliament was becoming agreeable to the transfer of the properties of the Hudson's Bay Company to Canada.* Also, the British Government was aiding in financing a railroad, now in operation in Nova Scotia (145 miles), in New Brunswick (234 miles), and it was agreed that, with confederation, the Dominion government would build a line connecting Halifax and the St. Lawrence, to a point "at or near Quebec." For the most part, opposition to confederation had disappeared, as had opposition to Ottawa as the capital city.

The long, hard wait was over. Confederation was at hand — and with the clock heralding the new day of July 1, 1867, the rolling refrain of 101 saluting guns brought the news to Ottawa, as the ringing of church bells in city and countryside announced to Canadians everywhere that they were one people.

When morning came, young and old, men, their wives and their children, all in Sunday clothes, filled the streets of city and town, or rode in crowded buggies over country roads, on their way to church and to prayer.

In the maritime provinces a few die-hards draped

*The transfer was made in 1869.

crepe over the doors of their shops, or flew flags at half-staff; but, for the most part, in the maritime provinces and elsewhere, there were parades and marching troops, the call of bugles and the music of bands. In Halifax, Toronto, Saint John, Montreal, Kingston and other communities, the people gathered in the squares or in the parks to listen while the mayor, in formal dress, read the proclamation that federated the provinces, and to cheer as the ceremony closed with a band playing "God Save the Queen."

In Ottawa, John A. Macdonald, soon to be Prime Minister at the age of fifty-two, was in his office in the Eastern Departmental Building waiting the arrival of the throngs that were moving from all parts of the city toward Parliament Hill to witness Macdonald's moment of high ceremony.

In 1863, the Geological Survey of Canada published a volume called *Geology of Canada, or A Report of Progress from Its Commencement to 1863,* in which appeared a section on nickel and cobalt. In opening the section the authors commented upon the frequency with which nickel and cobalt were found together, and surmised "the increasing demand for it [nickel] in the manufacture of German silver and of similar alloys, and its use in the coinage of the United States, of Switzerland, and of Belgium would make the deposits . . . worthy of further and careful explorations."*

*The earliest record of nickel being produced from Canadian ores was from the Silver Islet (on Lake Superior, near Port Arthur) discovered by Thomas MacFarlane in 1868. A smelting and refining works was built by the Silver Islet Mining Company, at Wyandotte, Michigan, to handle the silver ore. Nickel was extracted as a by-product prior to 1873. First owned by the Montreal Mining Company, the property was sold to the West Canada Mining Company in 1870.

Strangely enough, it was the least promising of the Canadian nickel deposits — the Quebec ores — that were first to be developed commercially. The men involved were R. G. Leckie, W. E. C. Eustis and Robert Means Thompson. Leckie was a mining engineer; Eustis was a Bostonian who was interested in mining and metallurgy; Thompson was a Boston lawyer. Eustis was his client. The nickel deposit was in the township of Orford.

The story is that Leckie was in Boston attending a meeting of the American Institute of Mining Engineers when he was introduced to Eustis. Likewise a member of the Institute, Eustis inquired about mineral deposits in Canada and learned of the Orford property, which was owned by Leckie. Accompanied by Thompson and Leckie, Eustis visited the site in September 1877. He found the mine holed into the side of a hill, but so dense was the native spruce that the party had to pitch camp half a mile distant.

Pleased over what he saw, Eustis bought the property. Two shafts were started, about one hundred and eighty feet apart. After sinking one shaft to a depth of approximately one hundred feet and a second shaft to an approximate depth of one hundred and fifty feet, Eustis began a crosscut to join them.

At this point he invited a Yale professor to examine the property. On the way to the mine, the professor was thrown from his buggy. With ruffled feelings, he completed the journey, made a cursory inspection, testily gave his decision: "Scratch the ground again, and then send for me"; and left. Unperturbed, Eustis went to Philadelphia where, on February 28, 1878, he read a paper before the American Institute of Mining Engineers in which he described his mine, spoke enthusiastically of

its possibilities, and said that while the ore was different from other nickel ores, the metallurgy would not be difficult.

A few days later (March 9, 1878) The Orford Nickel and Copper Company was organized by special act of the Province of Quebec. Under this special act, the company was authorized to mine, manufacture and sell nickel, phosphate, copper and other minerals. The incorporators were Charles C. Colby, Robert G. Leckie, Walter W. Beckett, William E. C. Eustis, and Robert M. Thompson. The capitalization was $300,000.

Using gas generators and reverberatory furnaces, Eustis tried to smelt the nickel ore. All that came out was a pasty mass of slag, but no metal. The furnace man was James McArthur, a Scotsman, who was trained by Sir Henry Bessemer.* Disgusted over the results, McArthur quit.

Nickel was up to its old tricks. A perverse metal, it refused to be persuaded, or soothed, or driven into doing what engineers and furnacemen wanted it to do. It had always been that way.

Joseph Wharton was first among American refiners to produce a malleable nickel. Owner of a small refinery in Camden, New Jersey, Wharton obtained his ore from the Gap mine in Lancaster County, Pennsylvania. His refining process was complicated and expensive.

The mine was opened in 1718, so tradition had it, as a copper mine. As a copper mine it did not amount to much. In 1853, the ore was found to contain nickel. Ten years later Wharton began experimenting and, after many

*The British engineer who concurrently with William Kelly invented the process of removing impurities from steel by forcing a blast of air through the molten mass.

trying experiences, produced the malleable nickel with which his name is associated in the metal industry.

It was an experience that persuaded him to go into business and, after he had been in business for a time, persuaded him to say he was "alone in the business because no other man in America has dared to embark in so difficult, and hazardous, a trade."

For nearly twenty years the Gap deposit was the most important nickel mine in North America. For much of that period its annual output represented about one-sixth of the world production. In 1891, the mine was closed, having produced a total of 2,000 tons of nickel.

Meanwhile, Eustis had lost interest in his nickel mine at Orford (actually, there was not much nickel in it) and had bought a property which adjoined the Crown mine at Capelton, near Lennoxville in Quebec. The owners of the Crown mine had worked the copper vein to a considerable depth before abandoning it because it dipped into the property held by Eustis. Under generally accepted law, the owners of the upper part of a mine could not follow the deposit into the adjoining property.

At first, Eustis proposed sinking a shaft to gain access to the copper, but was dissuaded because of the cost and the fact that two years would have been needed to complete it. Believing the owners of the Crown mine might be willing to lease the property for a reasonable sum, Robert M. Thompson was sent to London in 1878 to make such a proposal.

In London, Thompson learned that all the stock in the company was in the possession of John Taylor & Sons, mining agents, and that an application for dissolution of the company's affairs was about to be filed.

Instead of negotiating for a lease, Thompson proposed

to the mining agents that he take the stock off their hands at a price which would permit them to make a little money and, at the same time, save the expense of dissolution. The sum Thompson mentioned was acceptable, and the lawyer returned to Boston where, after making his report, he turned over the stock to Eustis.

In the questioning which followed, Thompson was asked why he had assumed responsibility for buying when his authority was confined to leasing. "I bought it on the authority of common sense," he told his fellow directors.

"What do you mean by that?" he was asked.

"I mean that I got the mine in perpetuity for what you were willing to pay for a two years' lease."

The purchase was approved; the mine was renamed the Eustis mine, and the directors suggested to Thompson that he serve as general manager of the company in the absence of Henry M. Howe (later professor of metallurgy at Columbia University), who was in Chile, and who was not expected to return for several months. Thompson accepted.

At a directors' meeting on April 26, 1879, Henry M. Howe was authorized to build three cupola furnaces and two kilns for "bessemerizing the ore," which contained iron and copper as well as sulfur, the latter in large quantities. McArthur again was in charge of the furnaces. He made matte* which was shipped to Hunt and Douglas, in Phoenixville, Pennsylvania, as well as to H. H. Vivian & Co. of Swansea, in South Wales.

This was a poor arrangement. Eustis believed the company should do its own refining. He began experimenting at Capelton, but the farmers protested so vigorously about

*An artificial sulfide of a metal or metals, in this case sulfides of copper, nickel and iron made by smelting-sulfide ore.

the heavy, acrid smoke that Robert M. Thompson was sent to New York in search of a suitable site for a smelter. He found what he wanted on New York harbor at Constable Hook, New Jersey. Here were four acres of sunken meadow that could be bought for little money.

The modesty of the sum — it was about $4,000 — attracted Thompson, as did the surroundings. Materials and fuel for smelting and refining copper were available. The sunken meadow was adjacent to property owned, and occupied, by the Standard Oil Company. Close by was a subsidiary, the Bergenport Chemical Company, which made sulfuric acid for the parent company.

Thompson called on the oil company, and suggested the use of sulfide ore in place of sulfur for the making of sulfuric acid. The oil company showed no interest. Thompson was persistent, arguing that by doing as he suggested, Standard could save money — and so sure was Thompson, that he offered to build a roaster and give the Standard Oil Company an option to buy if, at the end of six months, it was saving money.

In addition, he agreed to run the roaster for six months and at the end of six months the Standard Oil Company could take over the roaster by repaying the money Orford had spent in building the plant — plus a profit of 25 per cent on the investment — and give to Orford a five-year contract to use Capelton ore.

Under the terms of the proposed contract, the Bergenport Chemical Company was to roast the ore for the manufacture of sulfuric acid without any payment for the sulfur contained and then return the roasted ore to Thompson, who would use it as a raw material for producing copper.

With a signed contract in hand, Thompson bought

the four acres of sunken meadow from Franklin Osgood on September 6, 1881. He next visited city officials in New York. Having noted that the city was towing barges filled with rubbish several miles out to sea for dumping, Thompson suggested that money could be saved by waiting for high tide and dumping the waste on the convenient meadow.

Gradually, the meadow became real estate. At the end of six months, the oil company was so pleased with the arrangement that it exercised its option. Standard reimbursed Orford for the cost of the plant, plus the profit, plus the contract to use Capelton ore.

Four or five years before Thompson went to Constable Hook to establish a smelter, an itinerant inventor's interest in yellow fever caused him to observe that when sufferers were moved from hot climates to northern zones they sometimes recovered. Persuaded that climate had much to do with the incidence of yellow fever and its treatment, the itinerant inventor, whose name was John Gamgee, visualized a hospital ship containing rooms where the temperature could be kept near the freezing point. Operating on a regular schedule, such a ship could stop at southern ports, take on yellow fever patients, and freeze them back to health.

Gamgee went to Washington. There he met Samuel J. Ritchie, an Akron, Ohio, carriage manufacturer, who was stopping at the same hotel; in fact, on the same floor, and next door. Becoming acquainted with Gamgee, and interested in his ideas, Ritchie accompanied the inventor to a meeting of the United States Senate Committee on Epidemic Diseases, and added a persuading voice to Gamgee's request for an appropriation to be used for the building of a refrigerator ship. The committee agreed to appropriate $250,000, if Gamgee could prove he "could successfully produce and maintain the proper temperature in such a ship."

A machine shop in the Washington Navy Yard was placed at Gamgee's disposal, and he began building an ice machine. He had to use liquid ammonia as a freezing agent, so he conceived the idea of driving the machine with the gas generated from the ammonia by the heat of the atmosphere. It was his thought the gas would lose its heat in the task of operating the machine, would become reliquefied, and be ready again by the aid of atmospheric heat to generate more gas — and just keep going.

As for the machine itself, there were immediate difficulties. Gamgee was able to generate so great a pressure from the ammonia gas that the ordinary cast iron would not contain it. He tried one alloy, then another, and another. They all failed. Puzzled, but not discouraged, he said to the carriage maker:

"Ritchie, did you ever notice the meteorites at the Smithsonian Institution?"

Receiving an affirmative reply, Gamgee explained: "Well, we have no metallic iron on earth produced by nature in that form, and those meteors have all fallen from the skies, or have come from some other world. They nearly all contain nickel. Tomorrow we will send over to Philadelphia and get some, and try it."

With Ritchie's help, Gamgee obtained a small quantity of nickel from Joseph Wharton's plant in Camden, near Philadelphia. From it he made seventy-two separate pieces of iron and nickel alloys and carefully marked the nickel percentage of each. One alloy containing 8 per cent nickel*

*A 9 per cent nickel steel is an important cryogenic steel of today.

was especially attractive to Ritchie, and so sure were the two men that they had found an alloy "strong enough and hard enough to resist anything, and close enough in texture to resist the escape of any form of gas," that they invited the committee members to come and see for themselves.

The committee members came, and were so impressed that the way seemed clear for Gamgee to get his appropriation. It did not work out. Gamgee chose this moment to quarrel with the chairman of the committee over the cost and management of the proposed ship. The quarreling continued. The yellow fever epidemic waned with the coming of cold weather, and public attention turned to other things. The experiments for a refrigerator ship were dropped.

Ritchie could not have known it, but within half a dozen years he would be deep in the business of mining nickel; beckoning would be opportunities beyond even his dreams — and both his dreams and himself would disappear in a welter of lawsuits.

Ritchie returned to Akron and his carriage business. In need of second-growth hickory, he went to Ontario in 1881. He found hickory near Coe Hill in Hastings County; also, he found iron deposits. He bought 15,000 acres of timber and ore lands.

To get the ore to market Ritchie had to have a railroad. In Prince Edward County, across the Bay of Quinte from Hastings County, was the Prince Edward County Railroad which ran from Picton to Trenton, a distance of about thirty miles. Ritchie knew about this railroad because on one of his trips to Washington he met one of its owners, George W. McMullen, a resident of Picton.

Getting in touch with McMullen, Ritchie proposed buying the railroad, extending it to Coe Hill, about seventy miles north of Trenton, and renaming it the Central Ontario Railway. With his brother, J. B. McMullen, George McMullen joined Ritchie in persuading the provincial government to pass special legislation under which the Central Ontario Railway was incorporated and given the power to own and operate mines.

Back in Ohio, Ritchie called on three friends. In Cleveland lived H. P. Payne, United States Senator, who was interested in mining, and Stevenson Burke, who was interested in railroads; in Akron lived Thomas W. Cornell, who also was interested in mining. All were men of means. Ritchie proposed that after buying the railroad and extending it to Coe Hill, they buy an additional 65,000 acres of ore lands to add to the 15,000 acres already secured, and put them together.

The company was formed. It was authorized to issue $2,200,000 in bonds, and $750,000 in stock, of which $300,000 was preferred, and $450,000 common. Payne invested $200,000, receiving in return $100,000 in bonds, $100,000 in preferred stock and, as a bonus, $150,000 in common stock. In addition, he bought a third interest in the mining lands, paying $50,000. Burke put up $150,000, getting a similar amount in bonds, reserved the right to sell back the bonds to Ritchie, at par, and was given a guarantee by Ritchie to supply 100,000 tons of "first class Bessemer iron ore," from an iron mine to be opened on the Central Ontario Railway. Cornell advanced a substantial sum and was given bonds as collateral.

Ritchie bought out the McMullens. The railroad was completed in 1885. Mines were opened. After several thousand tons of iron ore had been shipped to blast furnaces in Cleveland, the company was informed that

the ore contained so much sulfur that it was almost worthless.

Wasting no time, Ritchie began looking for other mineral deposits which, under the terms of its charter, the railroad could own and operate. His search extended from Nova Scotia to Port Arthur and, half-minded to sell the railroad, he went to Montreal and called on William Van Horne, Vice President and General Manager of the Canadian Pacific Railway.

It was while he was waiting that he noticed several pieces of rock on a window sill near the desk of Thomas Tait, private secretary to Van Horne.

"What are those?" Ritchie inquired.

He was told they were specimens of mineralized rock Tait had picked up while on a trip to Sudbury in the spring of 1883.

Going to the window, Ritchie picked up the specimens, examined them closely, and asked a second question:

"Could I take these with me, and have them analyzed?"

Tait heard nothing more about the matter for a long time — then learned that Ritchie had acquired a number of claims in the locality where he (Tait) had picked up the specimens. Judging by events, Ritchie did not press his efforts to sell the railroad, but hurried from Van Horne's office to a mineralogist, had the specimens examined, sent a deputy to Sudbury, and then went himself. Visiting different properties, he bought some and took options on 97,000 acres.*

*In a letter (dated January 4, 1905) to Thomas W. Gibson, Director of the Ontario Bureau of Mines, Ritchie said he "located 97,000 acres, covering, in addition to what I had already purchased from individuals, every deposit of ore then known or since discovered in the whole Sudbury district, outside of what is now known as the North Nickel Range, twenty-five or thirty miles north of Sudbury, but which was then unknown."

Returning to Cleveland, Ritchie called on Payne and persuaded the Senator and his son, O. H. Payne, to take a quarter interest in the ore deposits. With the Paynes, Burke and Cornell, he formed two companies. One company was the Canadian Copper Company, capitalized at $2,000,000 and later increased to $2,500,000; the other company was The Anglo-American Iron Company, which was capitalized at $5,000,000. The two companies were chartered in Ohio in January 1886.

Later, when other properties were acquired, new stock in the Canadian Copper Company totaling $733,000 was issued to Ritchie, Payne and Burke, in proportion to the individual holdings. The stock issued for all the land totaled $1,733,000. About $600,000 was spent in developing the property. Of this amount, Ritchie supplied $62,300, which was less than half of what the Paynes, Burke and Cornell each subscribed. All received additional stock, in proportionate amounts, and at par.

To The Anglo-American Iron Company, Ritchie and Payne and John MacLaren turned over an undivided three-quarters interest in the 15,000 acres of iron land near Coe Hill, and the 65,000 acres to the north of the village. In return, each received $500,000 in stock at its par value.

Ritchie then made application to the Dominion government to grant, in Canada, all the powers and privileges the companies enjoyed under the Ohio charters. Approval was given, and two Acts of Parliament – one known as An Act Respecting the Canadian Copper Company, and the other known as An Act Respecting The Anglo-American Iron Company – were passed in June 1886.*

*Thirteen years afterward, or in 1899, it was discovered that under the British North America Act, the Dominion government had exceeded its authority.

The options Ritchie had taken on the 97,000 acres of copper lands in and near Sudbury were allowed to expire. It proved to be a mistake.

In 1880, and largely through the efforts of John A. Macdonald, the Canadian Pacific Railway was formed for the express purpose of completing a transcontinental line within ten years. As a first step, the company acquired the Canada Central Railway connecting Ottawa and Pembroke. In 1882, it began construction at Pembroke. By following the *voyageurs'* route, it had its trains running to Lake Nipissing before the end of the year. From here, and because there was no parallel waterway over which supplies and equipment might be transported to construction crews, the navvies had to meet the challenge of fallen trees, big timber, almost impenetrable underbrush and rocky terrain.

Surveyors and engineers had gone ahead locating a right of way and running a line for the laying of the tracks. After them came a gang of men and horses sent in to fashion a "tote road" over which supplies could be brought to the construction gangs which followed slowly behind the surveyors. Every few miles a camp was set up for the men, and stables built for the horses. In March 1883, when a camp was set up at Sudbury, the rails were miles north of the projected right of way. For some unexplained reason the engineers, with W. A. Ramsey as their chief, had gone to the north of the lake afterward named Ramsey Lake, instead of to the south.

As a result, when the gangs reached Sudbury they

Under this act, foreign corporations had no right to own real estate in Ontario; consequently, the conveyance of lands to the Ohio corporations was illegal and voidable. To overcome the infirmity of title, the officers of the companies secured from the Ontario government a retroactive license dating back to the time of the issuance of the deeds of conveyance.

brought their picks and shovels smack into an ore deposit only a few miles from the place where, twenty-seven years before, Salter and Murray had been attracted by the "presence of an extensive magnetic heap."

It is hard to say who was first to see the outcropping and allow his imagination to dwell on its possibilities. It may have been Andrew McNaughton; it may have been Dr. William H. Howey, first Canadian Pacific doctor in the area; it may have been one of many persons.

A stipendiary magistrate of Sudbury, and confiscator of all bootleg whiskey found in the district, McNaughton was chipping samples, and dreaming dreams, one day in the spring of 1883 when a sudden storm interrupted both. Starting for home in the gathering darkness, the magistrate became lost in the dense bush. He wandered completely around the village until, without food and almost exhausted, he tripped over a telegraph wire that had been blown from the branch of a tree.

Using the wire as a guide, he came to a camp set up by railroad engineers. Here, fifteen miles from Sudbury, he was found by Dr. Howey, who was in charge of a search party.

Dr. Howey was attracted by the same outcropping. He chipped off samples, and dreamed dreams until hearing official words familiar to McNaughton: "There is not sufficient [copper] in the ore to form a workable mine." In 1883, Tom Flanagan, a construction gang blacksmith for the Canadian Pacific Railway, also looked down the road of make-believe. At his feet were the outcroppings that had teased a magistrate and a physician. Flanagan, too, had his hour of buoyancy.

It was in this same year of 1883 that the railroad had made a cutting for its main line through this outcrop

beside which Flanagan had stood. It was samples from this cutting that Thomas Tait took back to Montreal. Others sent samples to Ottawa. This time the government report was quite different. Soon, prospectors were scouring the country and filing claims. But not soon enough for the specific property where McNaughton, Howey and Flanagan had tarried.

On February 25, 1884, Thomas Murray, his brother William, merchants from Pembroke, Henry Abbott and John Loughrin applied for a patent on the land. In October of the same year the patent was issued. The property contained 310 acres. The price paid was one dollar an acre. It is doubtful if any mining area of equal size anywhere in the world ever came into the market for so little money and, in succeeding years, passed through successive ownership that spent millions of dollars in development. The property became the Murray mine.

However, it was not a "prospecting rush" in the true sense of the word. Rather, it was a feverish eagerness among people living in the district. Florence Howey, wife of Dr. Howey, wrote about it saying: "more and more talk about claims and findings, buying and selling, and the price of copper . . . even the children picking up bits of rock and bringing them to show the yellow in them."*

A plunger, a spender, and a man of tremendous energy, Rinaldo McConnell was the best known of the prospectors. A timber cruiser for the Smith Brothers Lumber Company, McConnell argued too vigorously with his employers. They were interested in the growth of pine in McKim and Snider townships. McConnell was interested in the ore deposits in the same townships.

Out of a job, McConnell teamed up with Joseph

*See Appendix for Florence Howey's memories of early days in Sudbury.

Riopelle in the purchase of Lot 1, Concession 4, in Snider township. The deposit was the second ore body located in the Sudbury district, and became the Canadian Copper Company's No. 4 and 6 mines.

In partnership with James Stobie, another prospector, McConnell located the Stobie mine in Blezard township; working for him as a scout, Henry Ranger found the Victoria deposit in Denison township; an Indian told him about what became the Blue Lake mine in Capreol township; with Stobie, he owned the Levack mine in the township of the same name, as well as other properties; with the help of Ranger and R. J. Tough, he found gold and copper in Denison township. The property became the Vermilion mine.

Others who were prominent as prospectors and investors were J. H. Metcalf and W. B. McAllister, both Pembroke merchants, and Tough, who was in the clothing business in Sudbury. Metcalf and McAllister were involved in the Frood, Copper Cliff, Lady Macdonald and Creighton deposits. Henry Totten and F. C. Crean owned the Elsie, Worthington, Howland and Crean Hill properties.

In 1885 in Quebec, W. E. C. Eustis and Robert M. Thompson were having trouble getting enough ore to keep the Constable Hook smelter busy, so Thompson went to Butte, Montana, where there were silver mines and dumps rich with silver and copper.

Through James McArthur, his former furnaceman, Thompson obtained an introduction to United States Senator William A. Clark, who was one of the owners of a smelter in which McArthur was employed. Clark was not interested in supplying any ore or investing any

money in Thompson's smelter. Determined to get ore, if he could not get money, Thompson tried prospecting. A big man physically, and ruggedly built, he was forced to return to Butte because of a severe disability in one eye.

Again he saw McArthur and, on McArthur's advice, went to Clark a second time. From McArthur, and from others, Clark had learned that Thompson was industrious, imaginative and knew quite a lot about smelting, so that when Thompson repeated his offer Clark was very attentive.

With his brother, J. R. Clark, the Senator agreed to set up a smelting furnace in Butte. Thompson was to own one-half, and each of the Clarks was to own one-quarter, with the agreement taking the form of a two-year partnership. The partnership was known as Robert M. Thompson & Co., and the place of business as Butte, Montana. The capitalization was $60,000, divided as follows: W. A. Clark, $15,000; J. R. Clark, $15,000; Robert M. Thompson, $30,000. Having but $5,000 in cash, Thompson borrowed $25,000 from Senator Clark.

Under the terms of an agreement with The Orford Copper and Sulphur Company* which was signed on January 1, 1886, the company agreed "to carry on the business of buying copper and copper-silver bearing ores in Butte, Montana and neighborhood, and of procuring such ores to be smelted into mattes; and further agree that all such mattes and such ores as it may be better to ship without smelting in Butte, shall be shipped to said Orford Co., to have them smelted and refined, and the copper and silver and gold sold on terms hereinafter stated. . . ."

To protect his investment, Clark put his own men in

*So named on March 30, 1883.

the plant and in the office of Robert M. Thompson & Co. in Butte, as well as in New York, but left management of the company to Thompson.

Soon, the Butte operation was doing so well that Clark began working his copper mines and, looking to his own future, Thompson began thinking in terms of Sudbury as a possible source of ore for his Constable Hook plant. He sent a representative to the district. The representative returned with tales of "mountains of ore." Thompson went to Sudbury where he met Ritchie. Before long, the two men were on the best of terms.

As a promoter, it may be assumed that Ritchie personally escorted Thompson on a tour of his various mining properties. Among the properties were Copper Cliff, the Stobie, the McAllister, and Creighton mines. Before he left Sudbury, and before any mines were in operation, Thompson reached an agreement to refine 100,000 tons of Ritchie's ore in the Orford smelters.

Ritchie began shipping ore in October 1886. By the end of the year the shipments amounted to 3,307 tons having a customs value of $16,404. The ore went to Orford at Constable Hook, to the Nichols Chemical Company at Laurel Hill on Long Island, and to H. H. Vivian & Co. of Swansea, Wales. Accompanying the shipments were reports signed by a chemist in the employ of the Canadian Copper Company indicating that the copper content was about 7 per cent.

It was not long before there was complete confusion in the Nichols chemical works and in the Orford smelter. The ore looked all right, but refused to produce the right kind of metal. All that came from the smelting process was a pale, pinkish-gray, unsalable material. After repeated

attempts to make the ore behave, the Nichols company canceled its contract and turned over its ore to Orford.

Seemingly, it was the story of the Hälsingland mines in Sweden centuries before and the "kupfernickel," which Urban Hiarne, Swedish chemist, called it in 1694, or "devil's copper," from which no copper can be made.

More exasperated than discouraged, Thompson instructed Robert Hedley, his chemist, to continue testing the ore until he found the answer. After much testing, Hedley found the answer.

Instead of an ore containing 7 per cent copper, it was an ore containing 4½ per cent copper and 2½ per cent nickel.

Thompson wrote Ritchie informing him of the actual copper content of the ore. Dropping whatever he was doing, Ritchie lit out for New York. Storming into Thompson's office, he accused Thompson of "trying to swindle" him.

Equally quick-tempered, Thompson flared back: "Ritchie, you have never taken the trouble to have a complete analysis made of your ore. There is only four and one-half per cent copper, but there is also two and one-half per cent nickel."

From Swansea, in Wales, Ritchie had received more bad news. There was so much nickel in the ore that he did not realize a dollar a ton on his shipment.

Slumping into a chair, Ritchie was silent for a moment, then asked: "What is the price of nickel?"

"A dollar a pound," replied Thompson.

Springing back to his feet, Ritchie volleyed questions at an unimpressed Thompson, who pointed out that no one knew very much about the metallurgy of nickel, but said he was willing to make a proposition to Ritchie if first he could carry on a series of experiments. To conduct such experiments he offered to buy 1,000 pounds of matte on the basis of paying twelve cents a pound for the nickel content, and four cents a pound for the copper.

Incredulously, Ritchie demanded: "You mean if I supply the ore, you will give me twelve cents a pound for whatever nickel you find so you can turn around and sell it to someone else for one dollar a pound?"

Bluntly, Thompson replied: "Ritchie, you are being paid to enable me to make experiments which may, or may not, come to something. You don't know. I don't know. If you don't like the price, leave it alone."

Once past their moment of bickering, Thompson and Ritchie sat down together to look at the opportunity – if it was an opportunity. It was clear to both that the future of the Canadian mines depended upon the separation of the two metals, nickel and copper, and each recognized his part in such a program.

Ritchie and Thompson went back to their jobs – Ritchie to Sudbury to produce ore, Thompson to Constable Hook and talks with his people on how best to separate the metals.

4

A Glasgow Engineer Makes a Report

REALIZING that, in addition to large copper deposits, he had extensive nickel deposits, Ritchie was holding a loose rein over his ambitions.

With characteristic aplomb, he invited Sir John A. Macdonald and Lady Macdonald to visit Sudbury on the occasion of the renaming of the McAllister mine. The new name was the Lady Macdonald mine. Giving the mine a new name was, of course, an excuse. The real reason was to have the Prime Minister of Canada see the work that was being done by the Canadian Copper Company.

Sir John and his lady came; the mine was renamed; the Prime Minister was shown the mines in operation and taken on a tour of the properties.

Next, Ritchie invited William C. Van Horne, builder of the Canadian Pacific Railway, George Stephens, first president of the railroad, and Sir Charles Tupper, heir apparent to Macdonald's leadership of the Conservative Party, and a party of British capitalists who were traveling in Canada, to stop over in Sudbury. They did and in Sudbury, Van Horne's private car, the *Jamaica,* with its wide-curtained windows and its fine-meshed window screens tightly fitted to keep out dust and mosquitoes, was parked on a siding near the main track.

When darkness came a yard engine coupled to a number of cars loaded with ore — or what passed for ore — from the Copper Cliff mine made a series of trips up and down the main line, with its whistle wide open. With every passing, conversation was useless and sleep impossible in the private car until, in a moment of quiet, Van Horne pinned Ritchie with a disapproving stare and a cynical observation:

"Well, Ritchie, it seems you are finally getting some ore loosened up, and moving."

Nodding, Ritchie grunted a weak "yes."

Putting up with the racket through a couple of additional trips, Van Horne stepped through the door onto the platform of his private car. Vigorously waving his arms, he shouted at the train crew, ordering it to get out of the neighborhood and to stay out.

Still upset on the following morning, Ritchie sought out Van Horne to apologize for a disturbance that still mystified him. The railroad official was attentive but not sociable, saying he would "have to establish some sort of a policy covering such unnecessary noises after the regular workday was ended."

It was not until weeks later that Ritchie learned Van

Horne had arranged and directed the whole diversion. Whether Ritchie learned the reason for it is not in the record. It may have been that Van Horne was trying to help two friends, Sir John A. Macdonald and Ritchie, in their efforts (1) to attract English capital to Canadian enterprise; and (2) to bring about tariff reforms that would permit the shipment of Canadian products into the United States duty free.

On February 16, and again on February 17, 1886, Ritchie had written Macdonald requesting the Prime Minister to use his influence with the Canadian Parliament to concur with a bill that was being written by the Committee of Ways and Means, in the House of Representatives, in Washington. It was a bill which included, among other things, a list of products that could be shipped from Canada into the United States without penalties. In the list, according to Ritchie, were "lumber, coal, salt, iron ore, copper ore, lead ore, and probably all the ores of metals. . . ."

Replying on February 25, 1886, Macdonald explained it would be necessary to "await the legislation of Congress before taking any executive action," but "in the absence of a reciprocity treaty, which we should prefer, [the] arrangements could be made . . . by independent but concurrent legislation."

Ritchie's efforts to persuade Washington congressmen into making tariff reforms on Canadian products were not successful. He was disappointed, but not unhappy. In his immediate view was a new market for the nickel of his Canadian mines.

Learning that in Essen, Germany, the Krupps were experimenting with nickel as an addition to steel and iron, he wrote suggesting more extensive experiments.

The Krupps replied through their New York agents to the effect that they did not believe there was a sufficient quantity of nickel in the world "to warrant experiments looking to any extended use of the metal."

The Krupps were not so dogmatic as their decision would indicate. They were familiar with the New Caledonia deposits. They were equally familiar with the history of that island in the South Pacific ocean — that for more than three-quarters of a century after its discovery by Captain James Cook in 1774, it was unclaimed, and that it was not until September 24, 1853, that the French took possession.

Nickel was found in 1864, one year after the French government established a penal settlement on the island. In the years 1879-85, approximately 4,000 tons of matte were exported but because industrial consumption of the metal was not able to keep up with production of matte, shipments were stopped.

Also, there were deposits of nickel in Germany, the most important being the Frankenstein deposit in East Silesia, as well as the deposits in Norway, Spain, Italy, Russia, and one or two other places. In each country, excepting New Caledonia, the nickel content of the deposits was quite small.

The Sudbury deposits which soon were to rival the French holdings in New Caledonia were little known in Europe.

At Sudbury, the Algoma branch which the Canadian Pacific Railway built to bring supplies for the construction of the main line lay abandoned. In September 1886, the "Soo branch from Sudbury to Copper Cliff was in such a state of disrepair that trains moving over it were held to

eight miles an hour, or less." Consequently, with one stretch of rails in disuse, the other in a dangerous condition, and with inadequate sidings, freight cars were scarce and shipments always delayed, thus increasing costs.

In May 1886, when work began at the mines, there were twenty-five men on the payroll; at the end of the year, there were sixty-five. The payroll was about $4,000 a month. Meeting it was a subject of constant correspondence with the home office in Cleveland. Time after time the company had to hypothecate its assets and its stock to obtain bank loans that, in turn, might meet payrolls.

More optimistic than ever, Ritchie kept on buying properties, some of which were paid for by the issuance of treasury stock in the Canadian Copper Company.

There is no record that he ever admitted it, but somewhere in the recesses of Ritchie's teeming optimism there must have been a twinge—at least a twinge—of uncertainty.

Still, whatever his concern with new markets, Ritchie would have been intrigued by the dilemma that was confronting Robert M. Thompson.

In July 1887, Eustis and Thompson ended their partnership in The Orford Copper and Sulphur Company following withdrawal of financial support by Eustis's backers. Eustis kept the mine at Capelton, assumed the debts, and called his company The Eustis Mining Company. Thompson took over the smelter at Constable Hook, assumed its debts which approximated $450,000, and named his company the Orford Copper Company.

Pressing among the debts were several items. Nearly $25,000 was owed the Canadian Copper Company for ore; more than $100,000 was owed elsewhere, including banks; beyond those debts, the firm of Robert M. Thompson & Co. was liable for the payment of drafts amounting to $214,000 which it had drawn on The Orford Copper and Sulphur company. They were drafts that had been accepted by the Capelton company, and had been protested for nonpayment when the company became insolvent following the withdrawal of financial support.

Thompson went to see Senator Clark. An agreement was reached. As security for Clark's financial help, Thompson turned over the bonds and stock of his newly formed Orford Copper Company and, as additional security, included his half interest in the Butte smelter which had become a profitable undertaking.

The amount of the bonds and par value of the stock in the Orford company totaled $250,000; Thompson estimated his half interest in the Butte company to be worth in excess of $300,000.

Unlike the first agreement, which had a two-year term, the second was of indeterminate duration, its length depending largely upon the amount of time needed by Thompson to pay off the debts of his new company. Before seven months were over, Thompson had cleared off most of the liabilities. On March 17, 1888, the contract was canceled by mutual agreement. Thompson was still in debt to Clark, but was in control of his own Orford Copper Company.

In February 1889, an agent for La Societé Industrielle et Commerciale des Metaux, or "Secretan Syndicate" as this French company was commonly known, approached Thompson with an offer to take over the Constable Hook operation for a term of two years. The syndicate was in the process of buying or leasing a majority of the major copper smelters in the world. Thompson was agreeable, and an agreement was signed, the outcome of which no one could have foreseen.

Under the terms of the contract, Thompson agreed to refine 1,500,000 pounds of copper a month for two years, and was given an advance payment of $300,000. In return, he agreed that the charges for refining the ore would be used to liquidate the payment, unless the syndicate failed to deliver the ore. In the event of failure to deliver the ore, the monthly forfeiture on the part of the syndicate was to equal the monthly charge for refining.

Thompson's reason for insisting upon an advance payment was a familiar reason. He was short of money. While he had paid off most of his debt to Clark, he still owed the Senator $100,000 on a note which was due in a few days.

Shortly afterward, the first shipment of ore was delivered at Constable Hook. Instead of 1,500,000 pounds, the shipment contained 679,557 pounds — and before the syndicate could make up the balance, it was in financial difficulties.

The collapse of the syndicate and the bankruptcy proceedings which followed were inevitable. For almost a year and a half it had been a dominant factor in the copper market, and had kept its prices at an extremely high level. It was able to do these things because of (1) its resources which were capitalized at $80,000,000; and (2) its arrangement with all the important producers of copper. But, strong as these resources appeared to be, they were jerry-built, and were not able to remain standing before the natural laws of supply and demand.

With the collapse of the syndicate, Thompson had a problem: Who owned the ore already delivered to him?

Fearful of prosecution under the French Law of Accaparement (cornering), the syndicate denied ownership. So did Thompson. He was afraid that acceptance might weaken his position in the event he had to bring court action for damages under the monthly forfeiture clause in the contract.

Thompson tried to persuade the syndicate to take the ore off his hands. The syndicate refused, insisting that inasmuch as it was in his possession he should keep it. After much argument, Thompson kept the ore. It made little difference. Within a few months the monthly forfeitures for failure to deliver ore liquidated the advance.

A few years afterward R. G. Dun & Co., a mercantile credit organization, reported that in addition to being looked upon as "practically the owner of the company's stock and bonds, Mr. Thompson has been wonderfully prosperous. He went to England and traded in copper and is estimated to have made over $1,000,000 in his operations."

As for W. A. Clark and his investment in Robert M. Thompson & Co., the United States Senator from Montana got back his money, more than ten times over.

Late in the summer of 1887, Henry Ranger was working for R. J. Tough and was prospecting in Denison township, his favorite hunting grounds. He found gold and copper on Lot 6, in the fourth concession. On September 13, Tough applied for Lots 5 and 6, in the fourth concession, and on October 9 they were patented to him. On November 17, Ranger, Tough, James Stobie and Alexander G. Duncan, along with V. W. Foster and Robert Hill, of Chicago, organized the International Mining Company to operate the Ranger mine.

The name was not acceptable to Ontario authorities, and was changed to the Vermillion Mining Company.

Chartered on February 21, 1888, for the purpose of mining gold, the company was capitalized at $240,000, not much of which was in money.

Believing they had a gold mine because unusually rich specimens had been found in a quartz vein, the owners built a small stamp mill to treat the ore. To a depth of fifteen feet there was a good harvest. The yield was about $8,000 worth of gold. Mining deeper they found, at seventy feet, not more gold but one of the richest copper-nickel ore deposits yet found in Canada. Greatly disappointed, the owners began jangling among themselves, whether to go on or quit.

In December 1888, with the mine closed, The Anglo-American Iron Company bought $8,000 of Vermillion stock from Tough but, before so doing, Ritchie had assays of the ore made by Francis Lewis Sperry, a graduate of the Yale Sheffield Scientific School and chemist for the Canadian Copper Company. In making a fire assay for gold, Sperry obtained a small white bead which was not gold. Curiosity aroused, Sperry sent the bead to Horace Lemuel Wells, his old professor at the Scientific School in New Haven, Connecticut.

Suspecting what he might have found, Sperry set out to locate the exact source of the new mineral, the whole supply of which amounted to a few ounces. Learning from officials at the Vermillion company that the new mineral "was gathered on the carpet connected with the stamp mill," Sperry sent this information, as well as the accumulated ounces, to Wells. Joining Wells in the examination was Professor Samuel Lewis Penfield. Their findings were sent to Sperry. As the chemist suspected, the new mineral was identified as an arsenide of platinum.*

*Wells and Penfield published papers on the new mineral in December 1889.

At the suggestion of Ritchie, Wells called the new mineral "Sperrylite," and in a letter to Ritchie, dated November 6, 1888, Wells said:

> Mr. Sperry, aside from being a good friend of mine, deserves this honor for his good judgment in noticing that it was not an ordinary thing. I believe that many mining engineers would not have noticed it or else would have guessed it was some common mineral and not investigated it further. I hope you may find a lot of this, for platinum is worth about $6 an ounce, and the substance would be very easily worked for the metal.

Ritchie lost no time in getting samples of the ore into the hands of Frank Wigglesworth Clarke, chief chemist of the United States Geological Survey, and Clarke, in a letter written on January 26, 1889, declared that "this is the first authentic instance of the occurrence of platinum in true metalliferous vein material, and it has therefore remarkable interest. Economically it is notable only as a clue upon which future investigations may be based, but scientifically it is very important."

Ritchie was in disagreement with Clarke's opinion as to the economic *unimportance* of the platinum. He talked with E. D. Peters, general manager of the Sudbury properties. In June 1889, Ritchie received a memorandum in which Peters outlined the cost of smelting ore, saying "as for silver, gold, nickel, platinum, etc., they all go into the matte, and we have nothing further to do with them, it being solely the refiners' business to separate them and I do not know what the ore contains or how much the refiners would pay of the actual value of such a peculiar

mixture of metals, which is almost unprecedented, especially the platinum contents."

Unfortunately, the refiner Peters had in mind was in no position to do any experimenting to determine the gold, or silver, or platinum content of the ore. The refiner was Robert M. Thompson. At the moment, Thompson was concerned only with the separation of nickel and copper.

In 1888, the Canadian Copper Company decided to erect its own smelter that it might be relieved of the heavy expense of shipping "green ore" to H. H. Vivian & Co. in Swansea; C. Tennant, Sons & Co. in Liverpool; and to Orford in New Jersey. To obtain funds, the secretary of the company was authorized to pledge whatever amount of treasury stock was needed, and to make certain there would be enough money available in the building fund, each of the six directors promised to lend the company fifty thousand dollars, if necessary.

E. D. Peters, who had been with Eustis and Thompson at Capelton, was put in charge of the new operation. With him in the capacity of furnace manager was James McArthur.

A heavily wooded clay flat beside a small stream was selected by Peters as a site for a roast yard. It was a choice that was disputed by a colony of beavers. The dam the beavers had built across the stream was torn away. Overnight, the beavers rebuilt it. It was ripped apart, and built again. Ripped apart. Built again. Ripped apart. Built again. After a while the beavers surrendered. Most of them had been killed.

To remove as much sulfur as possible from the ore, a roast pile was built in the middle of a thick growth of spruce and birch trees. Peters described the building of a roast pile as follows:

> The ore, after being run through jaw-breakers at the mines, set to about 1¾ inches, is run in railroad cars to a high trestle which extends the entire length of a roast-yard, and from which the ore is dumped directly upon the heaps.
>
> These are made very large, about 40 by 80 feet, and some 6 feet high. Sound pine wood is used for the bed, and about one cord of wood is laid down for each 20 tons of ore in the heap. It is laid with great care, leaving air channels to the center of the pile, while the surface of the wood is evened off with chips and smaller wood, and everything possible is done to obtain strict uniformity of combustion. After the main body of the heap is formed of the coarse ore, the ragging, or middling-sized ore, is added, being about a foot thick at the base of the pile, and tapering up to a few inches at the top. The fines are lastly added in the same way, though not so thickly at first, and a considerable additional supply of the latter is placed in heaps around the pile in order to smother the fire after it is started.
>
> The heap is fired at night, on account of the smoke, and when possible, it was found best to wait until several piles were ready and then fire them all at once, thus concentrating into one short period the harassing escape of fumes that would otherwise annoy the workmen who were building up, or tearing down, neighboring piles, just as much every time each single one was lighted.
>
> A skilled and trusty man attends to the kindling

> and watching of the heap, and usually has to spend the entire night in working at it; filling up holes that appear from the burning away of the wood, and consequent sinking of the superincumbent ore; adding fines to those portions of the surface which appear too hot, and giving vent to those parts which show no sign of life. The entire success of the roast depends upon the building and lighting of the heap and its management during the first few days, and especially the first 24 hours.*

A month after the roast pile was built, Peters reported that "we have been putting 117 tons of ore a day on the roast yard. No man in America is heap-roasting half this amount of ore."

In less than a month the roast pile was a subject of controversy. Not only were the sulfurous fumes evil-smelling but, being more than twice as heavy as air, remained close to the ground unless dispersed by strong winds. Nevertheless, whether remaining close to the ground or being scattered, the fumes destroyed vegetation. Farmers emphasized the damages to their crops; the company minimized the losses. Each was careless in his claims.

In November 1888, the first furnace was built in Sudbury. It was a Herreshoff water-jacket furnace, six feet long, three feet wide and nine feet high. It was built by G. A. Nichols & Co. While the furnace was being assembled by a firm in Sherbrooke, Quebec, to which it was shipped in sections by the Nichols company, a furnace building forty feet long by thirty-five feet wide was erected. Installed in it were boilers and a blowing engine.

*_Modern American Methods of Copper Smelting_ by E. D. Peters. The Scientific Publishing Co., 1892.

D. H. Browne, one of the early officials at Sudbury, wrote of those days:

> On December 22, 1888, the furnace was fired up. The water jacket leaked and this leak seemed impossible to find. The floor of the furnace room was flooded and every time the furnace was tapped the explosions sounded like a Gatling gun. McArthur, who had to do most of the work himself, had a platform slung above the settler, and on this were stationed two men with pails [of water] to put out the fire on the roof which followed each tap. On December 25th McArthur's eyes were so badly burned that a boy was told to lead him around, so they closed down and hunted for the trouble.
>
> It appeared that the bronze connection ring which fitted between the furnace and the settler was the cause of the disturbance. The ring was hollow and water cooled. The Sherbrooke machinists had sawed it into four pieces, and fitted these together inside the iron work. With matte and slag running continuously over this split ring the only wonder is that any of the furnace men lived to tell the tale. After considerable vituperative correspondence [with the Sherbrooke company] a new tapping ring was fitted, this time in one piece.
>
> In January the furnace was started again, and Dr. Peters was delighted to find that he could smelt from 80 to 100 tons a day, producing a matte containing 50%, and a slag containing about 1½ to 2% nickel copper. This matte was shipped to H. H. Vivian, of Wales; to Chas. Tennant, of London;

> Wharton, of Camden, with occasional shipments to Hamburg. . . .

Before the end of 1889 matte was piled up in the smelter yard. There was little market for it.

In Cleveland, the Canadian Copper Company was having its usual troubles with money. On September 13, 1887, following a period of growing dissatisfaction with his management, Ritchie had resigned as president and director. His resignation as president was accepted. Thomas W. Cornell was chosen to succeed him, but needing his ability as a salesman, fellow directors persuaded Ritchie to remain as one of them.

Now, in May 1889, Ritchie did not know, nor did any official of the Canadian Copper Company, that 3,000 miles away, in London, James Riley, manager of the Steel Company of Scotland, Limited, in Glasgow, was presenting a paper entitled *Alloys of Nickel and Steel* to the Iron and Steel Institute of Great Britain. It was a paper in which Riley said, in part:

> I find some difficulty in not becoming enthusiastic . . . for in the wide range of properties, or qualities, possessed by these alloys, it really seems as if any conceivable demand could be met and satisfied . . . its non-corrodibility will render it invaluable for a great number of purposes.
>
> This quality of non-corrodibility, considered together with its strength, both elastic and ultimate, when unannealed, will render it specially useful in all cases where the cost of metal is of minor importance when contrasted with the cost of labour to be expended upon it, or its use for special purposes:

illustrations of these may be found in all small and special type boilers, in locomotive and other fire boxes, and in the hulls of torpedo and other similar vessels where lightness and strength with non-corrodibility are of vital importance.

. . . these metals are equally important to the shipbuilder and to the civil engineer. This is strongly brought out in considering the immense advantage to be derived from their use in large structures. Think of this for a moment in connection with the erection of the Forth Bridge, or the Eiffel Tower.

If the engineers of those stupendous structures had had at their disposal a metal of 40 tons strength and 28 tons elastic limit, instead of 30 tons strength and 17 tons elastic limit in the one case, and say 22 tons strength and 14 to 16 tons elastic limit in the other, how many difficulties would have been reduced in magnitude as the weight of materials was reduced; the Forth Bridge would have become even more light and airy, and the Tower more net-like and graceful than they are at present.

Then, as regards the requirements of the military engineer, I am inclined to state firmly that there has not yet been placed at his disposal materials so well adapted to his purposes — whether of armour, or of armament — as those I have now brought under your notice.

In what may be called their natural condition these alloys have many properties which will commend them for these purposes, and when the best method of treatment, by hardening or tempering, has been arrived at, I believe that their qualities for armour will be unsurpassed.

Obtaining a copy of the report, Ritchie stopped off in Washington on August 4, 1889, while on his way to Europe in search of markets for the nickel matte that was continuing to pile up in the smelter yard at Sudbury. In Washington he showed Riley's report to B. F. Tracy, Secretary of the United States Navy. After reading it, Tracy listened as Ritchie explained that, with Cornell, he was going to Europe to find out about "nickel being used in naval matters"; and if this was the reason for the recent receipt of "large orders from Europe for nickel."

After a discussion of the possible uses of the nickel-steel alloy in ships, the Secretary of the Navy told Ritchie he would put him in touch with Lieutenant B. H. Buckingham, naval attaché, in London, and that Buckingham would be instructed to go with Ritchie "to aid and assist in such investigation."

From Ottawa, a deeply interested Sir John A. Macdonald notified Ritchie that he had requested Sir Charles Tupper, Canadian High Commissioner in London, to accompany Ritchie on his trip "to find out," as Ritchie told his fellow directors, "whatever might be learned in Europe about the uses and the alloys of nickel and steel."

Before leaving Washington Ritchie called on the Secretary of the Navy a second time — to show a telegram which contained an offer by the Krupps to take the entire output of the Copper Cliff mine for three years, without limit as to quantity. Tracy urged Ritchie not to enter into any such arrangement until the Navy Department completed the investigation about to be made. To this Ritchie agreed.

In Europe, Cornell, Tupper and Buckingham went with Ritchie to the Krupp works in Essen, and to other iron and steel plants in France and Great Britain. Following receipt of Buckingham's report, the Secretary of the Navy wrote to William McKinley, Jr., Chairman of the Committee on Ways and Means of the House of Representatives, telling of Ritchie's visit, and of Buckingham's report which Tracy invited the future President of the United States to read, and closed his letter:

> While Mr. Ritchie was in Europe I discovered from another source that at Creusot, the greatest steel establishment in France — the one connected with the Bethlehem Company in its contracts with the government — had been experimenting with nickel for more than a year with most excellent results and had produced a plate nine and one-half inches thick which had proved to be much superior to all armor plates theretofore manufactured at that establishment. As a result of this investigation the department has purchased from Creusot a nickel steel armor plate. It is expected to reach this country within the next six months.
>
> I have investigated the subject far enough to have great hopes that the nickel plates will prove as far superior to steel as steel has to iron. If my anticipation in this report shall be realized it will be of great importance to the Government to secure the first option on a large portion of the product of the Canadian Copper Company, as that company produces, I am informed, three-fourths of the entire nickel product of the world. The foregoing seems to me to have an important bearing upon the question as to whether this company should be permitted to

> introduce their ore free of duty, to be smelted in this country.
>
> I am informed that results equal to these obtained at Creusot have also been obtained by William Jessop & Sons, of Sheffield, England, and by the Steel Company of Scotland, Glasgow.

While in Europe Ritchie made an effort to improve the prospects of the Canadian Copper Company by recommending to the Krupps that they extend their operations to Canada. In a letter dated November 3, 1889, Ritchie told Friedrich Krupp that the Dominion "now has 13,000 miles of Railway, and is without any rail mill, or steel plant, of her own."

Continuing, Ritchie said the Central Ontario Railroad was being

> extended from Coe Hill to Sudbury to connect the Iron Mines at the former place with the Nickel & Copper Mines at the latter place, and it is the intention of the Company to go extensively into the manufacture of ferro-nickel. . . . We have the greatest abundance of iron ores upon the line of our own road and as any large rail mill erected there would have the exclusive market of that country I believe the opportunity is unusually good for the erection of one.
>
> Sir Charles Tupper is the High Commissioner for Canada here in London. He was Minister of Railways and Minister of Finance during the construction of the Canadian Pacific Railway, and nearly the whole railway system of Canada has grown up under his administration and direction, and he would strongly favor any such enterprise as I have indicated.

Ritchie's negotiations with the Krupps and with the French brought offers that were disturbing to Tupper. In his report to Macdonald, Tupper told of going with Ritchie to the headquarters of Société Le Nickel, in Paris, and listening while the French sought to persuade "the Canadian Copper Company to agree to let them have control of their entire output."

Leaving Le Nickel, Ritchie and Tupper then went to Société Le Ferro Nickel, also with offices in Paris. Here again, as Tupper informed Macdonald, Ritchie was

> pressed . . . in the strongest possible manner to give them sole control of [the] product. The Canadian Copper Company, however, declined in either case to make any contracts with either the Nickel or the Ferro Nickel companies.
>
> From Paris we went to Hamburg in Germany. Parties from Vienna who are largely engaged in the manufacture of nickel came to this place to meet us in connection with the Hamburg people. They wanted to contract with the Sudbury people for a period of ten years for the delivery of a large amount each year. They offered to buy the matte as now produced at Sudbury and to erect refining works at Hamburg for the refining of nickel and copper. They pressed the matter very earnestly.
>
> They offered to send Mr. Krupp, a nephew of the great gunmaker to see the property and learn if some arrangements could not be made by which they could become identified in the ownership of these properties. The best evidence I could obtain of the real importance of the Sudbury mines was the manifest desire both in England and upon the continent

> of the largest smelters and consumers of both copper and nickel to become owners of the mines or to control their output.

The temptation to sell must have plagued the owners of the Canadian Copper Company.

Thousands of tons of matte were piled up in the smelter yard at Sudbury – 9,000 tons, so it was said. As security for bank loans it had no value, so small was the market. Company overdrafts at the banks amounted to as much as $300,000, all being secured by the personal endorsements of three men, Henry B. Payne, Stevenson Burke and Thomas W. Cornell. The demands for money, already sizable, were increasing. To meet payrolls, and to keep the company going, the three men had pledged their individual fortunes. From its beginnings the company had been a losing venture.

Instead of making a choice between two offers, each of which guaranteed a large profit, the three citizens of Ohio sought the advice of Macdonald and Tupper. They were advised to have the same faith in the future of their Canadian properties that Macdonald and Tupper had in the future of Canada. They accepted the advice. In giving the advice, Macdonald made only one promise: fair play.

5

A Break That Had to Come

UPON his return from Europe, Buckingham was ordered to investigate the nickel deposits in Sudbury, and "report fully" on what was seen, and found.

Accompanied by Commodore William M. Folger, Chief of the United States Navy Bureau of Ordnance, Buckingham went to Sudbury. Under date of October 14, 1890, the officers made a detailed report to the Secretary of the Navy. They estimated the "tons of ore above the surface of the ground in deposits seen by us 650,000,000," and told the Secretary, "We are fully convinced, from the surface indications and the shafts already sunk, that they have an amount of mineral which cannot be exhausted by this generation."

Riley's speculation that the alloy of nickel and steel could be "specially useful . . . in the hulls of torpedo and

other similar vessels" had made a deep impression on Tracy, and it was the conviction of the Secretary of the Navy that it was, as he said, "a promise too great to be ignored by a Government requiring 20,000 tons of armor for its new fleet."

Already the nickel steel plate ordered from the Creusot works in France had passed the tests. At Annapolis, Navy guns shattered the regular armor plate made of carbon steel. There was no penetration of the nickel steel plate by the same guns. Without delay, Tracy requested an appropriation of one million dollars for the purchase of nickel — and his plea was so urgent that within one hour after its receipt, Congress made the appropriation. Tracy bought 4,596 tons of matte from the Canadian Copper Company.

Events were tumbling over each other. Copies of the Folger-Buckingham report were given wide distribution, and newspapers were filled with articles about the Sudbury deposits. News of the Annapolis tests was carried by telegraph and by cable to all parts of the world, bringing discussion and comment such as was printed in the Glasgow *Herald* on October 27, 1890: "When the irresistible nickel plated breech-loader confronts the impenetrable nickel plated ironclad then indeed . . . war as a fine art will come to an end."

Members of the British Iron and Steel Institute held a special meeting in Niagara Falls, and then visited the mines. The American Institute of Mining Engineers met in Ottawa, and then visited the mines. Members of the Toronto Board of Trade, officials of the Canadian Pacific Railway and members of the Parliament visited the mines.

Brimming over with enthusiasm, Ritchie, on November 10, 1890, presented to Sir John A. Macdonald an expansive proposal. It called for the building of nickel refineries and steel plants on a vast scale in Canada. Visualizing himself as head of this industrial empire, Ritchie argued:

> Canada possesses probably five-sixths of the world supply of nickel. Such being the case, she can control the markets of the world, and the uses to which the metal shall be applied. She also has inexhaustible supplies of iron ore which, until the invention of nickel steel, were neither available for manufacture at home, nor saleable abroad.
>
> The comparative close proximity of these iron ores to these nickel deposits, both of which are inexhaustible and in almost incomputable supply, would seem to render any argument unnecessary as to the proper use to which they should be put. That they should be manufactured in Canada, and the manufactured materials shipped to the markets of the world, instead of only the crude materials being produced in this country and shipped to foreign markets, would seem to be a question susceptible to only one answer.

Ritchie outlined his needs. Among them was a subsidy from the Dominion as well as the provincial government that would enable him to extend the Central Ontario Railway to a point near Sudbury, and additional money to build steel mills, as well as smelting and refining works.

Early in 1891 (January 30), and at the instigation of Ritchie, a deputation of prominent people, one hundred in all, waited on Sir Oliver Mowat, Ontario's Premier, to request him to use his influence in bringing about the

building of a refining and smelting works in Toronto. Instead, the Ontario government, having withdrawn from sale all unpatented nickel-bearing lands in the province, sought to interest the British government in a joint effort to establish nickel refineries and steel mills in Canada.

In dispatches from Mowat and A. S. Hardy, Commissioner of Crown Lands, the British government was offered a large — perhaps even a controlling — interest in Ontario's nickel deposits. The Lords Commissioners of the Admiralty, to whom the dispatches were referred, were unimpressed. They declined to consider the proposition, sufficient nickel to meet the needs of Her Majesty's Navy. In June 1891, the Order-in-Council withdrawing the nickel lands from staking was rescinded.

While these things were happening in Canada and in England, criticism lingered in Washington because of the quick action by Congress in approving the Secretary's saying they did not anticipate any difficulty in obtaining request for one million dollars with which to buy nickel. Rumors found wide circulation that the "new armor is brittle when subjected to cold"; "its magnetic properties disrupted ships' compasses"; "for hard usage it is untrustworthy" — there were all sorts of rumors.

In 1890, a million dollars was a very large sum of money, even in government. In that year, the entire cost of maintaining the Government of the United States was less than $75,000,000. As for nickel, few persons, comparatively speaking, knew anything about it. "In fact," as W. P. Blake wrote in 1883, in recalling an exhibit at the Paris Exposition in 1878, "very few chemists had ever seen nickel. Pure nickel was a rarity . . . it was not strange, therefore, that the chemists and metallurgists of Europe on the international jury showed some incredulity when whole ingots and forged bars of metal and numerous finished articles of pure wrought nickel without alloy were offered for their inspection."

Despite the rumors, and the criticisms, the Navy continued to experiment, using nickel in guns, in sections of nickel steel propeller shafting for the battleships *Brooklyn* and *Iowa;* equally undisturbed, the Bethlehem Iron Company completed a spare nickel steel crankshaft for the American liner *Paris;* and, in further tests, the Bethlehem company bored holes in nickel steel ingots, filled the holes with dynamite, plugged the holes and exploded the charges. Excepting for loud noises nothing happened.

As targets the Navy used 10½-inch nickel steel plates made by the Bethlehem company. In the test, shells were fired from an eight-inch gun. In his 1892 report, Tracy wrote:

> Five Holtzer forged steel shells, weighing 250 pounds each, with a striking velocity of 1,700 feet per second, and each with an energy of 5,000 tons to the square foot, were fired at a distance of 30 yards.
>
> Never before these trials had any armor plate in the world been subjected to such a test as was represented by these five blows of a total energy of 25,000-foot tons.
>
> The result may be told in a word. All five of the projectiles were smashed upon the surface of the plate. The plate showed no signs of injury further than the opening of a slight temper crack four inches in length from one edge, and a wale less than one inch in thickness on the back of the plate opposite each point of impact.

> The striking ends of the projecticles appear to have been splashed on the face of the plate, filling the slight indentation made by the blow with new material which became welded to the substance of the plate itself and left it as before a flush surface. The remainder of the projectiles could only be found in the shape of innumerable fragments. . . .

Behind the report of the Secretary of the Navy was the work of Hayward Augustus Harvey, American inventor and steelmaker.

In 1889, and at the age of sixty-five years, Harvey treated a plate of nickel steel in a way which added a hard face to its inherent toughness. Learning of the experiment, the Navy Department, in May of the same year, supplied Harvey with a small plate six inches thick, and asked him to harden it. This was done, and it was the first of many tests made by Harvey in the development of armor for the United States Navy. They were tests that added two verbs to the vocabularies of steelmakers, the words being "Harveyized," as used in the United States, and "Harveyed," as used in Europe.

For quite a number of years after the sides of ships first were protected by iron plates, the power of guns and projectiles was well beyond the capacity of iron plates to protect. In 1861, nearly four years after the first such use,* armor plate four and one-half inches thick was becoming inadequate; in 1879, the British battleship *Inflexible* carried armor two feet thick, backed by seventeen solid inches of teakwood — and soon this was insufficient, so rapid were the improvements in guns and projectiles.

*The first two armored seagoing battleships, the *Gloire* (French) and the *Warrior* (British), were started in March 1858 and June 1859, respectively. The *Gloire* had broadside protection of 5 in., and the Warrior of 4½ in. iron plates.

Steel was used in place of iron, but steel, when hard, was too brittle as iron was too soft. As did others, Harvey experimented with nickel steel and, by 1890, had a plate that possessed a surface hard enough to pulverize a projectile and a back tough enough to sustain the hard surface. Continuing his tests, he continued to improve his process so that when reporting to Congress the Secretary of the Navy but echoed the words of Commodore Folger, as reported in *The New York Times* on July 30, 1892:

"The test showed this to be the most wonderful armor-plate ever made."

Harvey died in August 1893, not long after the formal adoption of his process by the Government of the United States.

In his report (1892) to Congress, the Secretary of the Navy stated that the payments to the Canadian Copper Company for matte amounted to $321,321.86, while freight costs were $31,134.88, duty on the copper contents, $9,547.40, and refining by the Orford Copper Company (in part, estimated) $97,582.30, making a total expenditure under the appropriation of $459,586.44.

"Of the nickel oxide produced by the Orford Company," stated the report, "we are now using 40 per cent, while 60 per cent is sold in Europe. Our material, after the payment of all charges including the price of the matte and of the subsequent reduction, costs us 24 cents a pound while that of the other consumers costs them at least 38 cents."

All the events leading up to the signing of contracts for the delivery of nickel to the United States Navy were not routine.

Hearing about the negotiations between Tracy and Ritchie in the fall of 1890, Thompson commented on them to a friend, who was a captain in the Navy. In the conversation (as recorded in Thompson's papers) Thompson, who was a graduate of the Naval Academy, warned against paying a rumored price of forty cents a pound for nickel, saying if such a price was paid, the Navy Department "might find itself involved in a scandal."

"How can you say that, Thompson?" argued the officer, "when all over the world nickel is selling for one dollar a pound?"

"Because all over the world nickel is being sold in small quantities. This is an entirely different matter. According to the information that has come to me, the Navy is negotiating for five million pounds. For such a quantity the price should come away down."

A day or two afterward Thompson received a telegram signed by the Secretary of the Navy. His presence was requested in Washington. Responding, Thompson walked into the Secretary's office to hear an angry voice: "Young man, don't you know that you can't buy nickel anywhere in the world for less than one dollar a pound?"

"No sir, I don't know anything of the kind."

"Then you're a very ignorant young man," shouted Tracy, hammering the desk with his fist.

Thompson, who had remained standing, turned on his heel and walked out saying, "Good morning, Mr. Secretary."

The following morning when he arrived at his office in New York, Thompson found Tracy waiting. Apologizing for his words of the previous day, the Secretary of the Navy smiled, saying, "You are a very sudden young man, but I know of your interest in the Navy and I have come to see you to get the facts."

Going to his files, Thompson extracted his agreement with Ritchie to pay twelve cents a pound for whatever nickel he was able to refine from matte shipped to him by the Canadian Copper Company. As he finished reading, Tracy looked up, protesting, "But this is an exceptional sale."

Thompson shook his head, and offered to get bids. Greatly interested, Tracy inquired: "What do you figure the nickel should cost us?" Putting together a number of estimates, Thompson guessed the cost of nickel to the Navy would be twenty-two or twenty-three cents a pound and, at Tracy's suggestion, went to Washington to see Commodore Folger, Chief of the Bureau of Ordnance.

Folger told him that negotiations had been completed with the Canadian Copper Company for the purchase of matte, and the Secretary was seeking an answer to the question: "Now that we have bought it, what are we going to do with it?"

"That's up to you," answered Thompson.

"Who can we get to refine it?"

"The only nickel refinery in the United States is over in Camden. It is owned by Joseph Wharton. Go and see him."

"We have. He wants too much money for the nickel."

"Does he know you are supplying the matte?"

"No."

Thompson stated what he thought were fair terms and, at Folger's request, wrote a memorandum for Tracy's guidance. In the memorandum Thompson estimated "the cost of nickel to the Navy should be twenty-three cents a pound." Satisfied he had made a good deal for the Navy,

and for Wharton, Thompson returned to New York where, with pleasure, he told associates of the price and added, "At this figure, the Navy can make a low offer and Wharton can do a little bargaining."

The recommendation did not work out as he expected. Navy officials were in no hurry to get the metal. As a result, there came an occasion when the telephone rang in his office. He answered, and heard a voice calling from Constable Hook, saying:

"Colonel, one hundred cars of matte have come in from Canada. What do you want us to do with it?"

"Nothing. It's a mistake. It must be the matte that belongs to Wharton."

Thompson telegraphed Folger, and in reply, Folger asked him to come to Washington. In Washington, Folger informed him: "The Secretary told me to ship the matte to you. He expects you to return the nickel to us according to the terms of the memorandum you gave me."

"I did not give you the memorandum on that basis, at all. I don't know anything about refining nickel, Folger. I told you that. I'm only experimenting with it."

"Yes, I know. So does the Secretary. He wants you to supply the nickel. We won't be wanting nickel for a long time, probably for another year or two. So, you go ahead."

When the time came to ship the metal to the steelmakers, Thompson had worked out a process that produced a red oxide of iron and nickel which was acceptable. There was one hitch. Thompson's costs for extracting the nickel from the matte were almost equal to the price of twenty-four cents a pound paid by the Navy.

Thompson was not disturbed. Waiting until deliveries to the steel companies were nearing completion, he went to Washington. His friends at the Navy Department were glad to see him and particularly was Commodore Folger glad to see him. Commodore Folger had a bill. It was a bill for $180,000. He presented it to Thompson.

After a quick glance and a moment of unbelief, Thompson overwhelmed the silence by bellowing: "What the hell is this for?"

"It's the duty on the copper in the matte that was shipped to the Orford company," explained Folger.

There is no record of the conversation which followed. There is a record of what happened. Thompson recalled, in precise detail, the contents of the memorandum he had written for the guidance of the Navy in dealing with Joseph Wharton in fixing the price for nickel—and argued that the fact that he, and not Wharton, did the work did not change the terms.

Finally agreeing, Navy officials informed Thompson that his accurate recollection of the contents of the unsigned memorandum was sufficient evidence to support his claims, and withdrew the bill. Much relieved, Thompson returned to New York.

Other than their confidence in Thompson, there was a reason for the willingness of Navy officials not to be in a hurry to ship nickel to the steelmakers. Navy officials wanted to be sure American steelmakers could produce a satisfactory armor plate; also, they wanted to find out which of several suggested methods gave the best results.

Tests proved that both the high nickel Harveyized plate, and the American high-carbon nickel steel plate were superior to the armor plate in use by the United States Navy. Likewise, it was established that first-rate armor plate could be produced by rolling. This was significant. If rolled plates could be substituted for forged,

it meant there would be substantial savings; it also meant that the work could be thrown open to a number of firms that previously had not been able to submit bids.

In the beginning, two companies, Bethlehem and Carnegie, Phipps & Co., Limited, had a corner on the making of armor plate. Profits were large. But then, so was the cost of setting up special plants. Bethlehem had a huge forging plant. Beyond that, its officials had the foresight, and the courage, to buy from Schneider and Co., of Le Creusot, all the rights to manufacture armor plate according to Schneider's process. The price paid was large. For their part, Carnegie, Phipps & Co. manufactured armor plate by rolling.*

Armor plate, of course, was not the end of the line for nickel steel. Had all the navies in the world switched to the new armor plate the nickel tonnage would not have been impressive. According to the 1892 Report of the Secretary of the Navy, the quantity of armor plate required for an ordinary warship (3,200 tons was the average) was not large. According to this report the quantity of nickel needed for such a ship was about 104 tons.

Nevertheless, the introduction of nickel steel into armaments was the most important single factor in the development of the nickel industry. It offered the first large-scale use of the metal at a time when a production of less than one thousand tons a year satisfied its princi-

*There has been little change in the composition of heavy armor during the last fifty or sixty years because no steel has been developed that is superior to the conventional Krupp analysis, which contains about 4 per cent nickel and 1½ per cent chromium. Both the face-hardened and homogeneous types for combat ships and heavily protected shore fortifications are processed from this nickel alloy steel. With the exception of the addition of molybdenum to the base composition, improvements made in heavy armor have resulted from advances in processing rather than from changes in composition.

pal uses. The uses were in coinage, nickel plating and nickel (German) silver.

In Cleveland there was restrained optimism. The purchase by the Navy was encouraging, although thousands of tons of unsold matte were in the smelter yards. Increasingly, there was determination by the directors "to make the property at least self-supporting," and, as the minutes of their meetings also disclose, a growing impatience with Ritchie's untidiness in his obligations to his associates.

Ritchie's earlier attempt to persuade Sir John A. Macdonald to approve the granting of a subsidy to extend the Central Ontario Railway and to build steel mills and smelters which would be put together with the operations of the Canadian Copper Company and The Anglo-American Iron Company was embarrassing to the other directors, and contrary to policies already established. The embarrassments continued.

Carried away by the vision of furnaces and mills, cities and towns and villages, and endless trains of ore along the route of the Central Ontario, Ritchie skipped over the rebuff of the British and Canadian governments to his dream of riches in great measure, and as easily dismissed the opinion of steel manufacturers that the excessive content of sulfur made the Coe Hill mine practically worthless. Equally he swept aside the directors' expressed policy of not committing the company to some steel-making venture.

Previously, hearing that Thomas A. Edison had built what was called a Magnetic Ore Separator, Ritchie wrote the inventor, and asked among other questions:

Q. Do you think it practicable and advisable to put

up a blast furnace for smelting this ore, and a steel plant for the manufacture of steel in Canada? If so, what measures are necessary to be adopted by the Dominion Government?

A. Yes. A protective tariff and a bonus for eight years.

Q. Are you willing to become interested in the smelting and manufacturing of iron and steel in Canada?

A. Yes.

The directors already had decided against such a steel venture. The directors were right. By the decision, the directors probably saved Edison — and themselves — from losing a lot of money, but angered Ritchie. Charged by Ritchie with timidity and cowardice, the directors met on January 5, 1891, removed Ritchie as a director, and terminated his connections with the companies. The split was long coming, but was inevitable.

On paper, Ritchie was the largest stockholder; in fact, he owned much less. A great deal of the stock that had been issued to him was held by Payne, Burke and Cornell as collateral for money they had loaned him. In amount, the sum was not far away from a million dollars. They were borrowings that had extended over a period of years.

Ritchie began a long series of lawsuits, including one that sought to dissolve the two companies, Canadian Copper Company and The Anglo-American Iron Company. This suit was based on an Ohio law which permitted a minority stockholder, under certain circumstances, to sue for the dissolution of a corporation if it had not paid a dividend of 6 per cent in five years. There were many lawsuits, all complicated in their charges, and all designed to harass the companies — which they did, for years. In their midst, one day, appeared another suit.

This was a suit, not against the companies although they were involved, but against Ritchie. It was brought by James B. McMullen and George W. McMullen, of Picton, and charged Ritchie with failure to live up to the terms of the contract under which they had sold their interest in the Central Ontario Railway. This was a suit Ritchie also lost and, because the stock he had used as collateral for his borrowings was brought into the testimony, the Court felt itself impelled to examine the histories of the two companies.

In affirming the judgment of $265,370 in favor of the McMullens, the Court said of the defendant:

> Difficulties did not deter him, nor danger affright him. In his mad pursuit of what he believed could be made out of these properties, he could not be restrained by his associates. Their caution was, in his judgment, timidity and cowardice. He acted as if he owned the whole property, and, when his advice was rejected or his unauthorized contracts repudiated, he pronounced the conduct of his associates as treasonable, malicious.
>
> The conservatism of Payne, Cornell and Burke was never a barrier to his exertions, or an obstacle to his plans. He never saw difficulties in the way of the development of these properties, and their consolidation with the other great nickel mining companies of the world. To these ends, he devoted himself with the zeal of a crusader.

As, indeed, he did.

In 1892, four companies were producing in the Sudbury district. They were the Canadian Copper Company; H. H. Vivian & Co., a Welsh concern; the Dominion Mineral Company, a Canadian company; and the Drury Nickel Company, an American firm. Together they mined 72,349 tons of ore, smelted 61,924 tons, produced 1,880 tons of Bessemer matte, and 6,278 tons of blast-furnace matte, which contained 2,082 tons of nickel.

In operation were three mines belonging to the Canadian Copper Company — Copper Cliff, Stobie and Evans — and two furnaces, each with a capacity to smelt about 125 tons of ore daily. At the Copper Cliff mine, in addition to extensive surface quarrying, was a shaft sunk to a depth of 350 feet, with drifts running at right angles for a distance of 500 or 600 feet. At Stobie were two tunnels, each with a penetration of 30 or 40 feet. At Evans, a dozen men were busy exploring a deposit that Peters was sure would be "better than any we have," and shored up his prediction by adding, "It carries about the same amount of metal as the other mines, but there is more massive ore, and a larger body of it."*

The companies were handicapped by lack of experienced help. Because of remoteness, it was difficult to get miners. For the most part those who came were Cornish and Welsh. They were paid monthly, in cash. The paymaster made his rounds in a buggy or a cutter, depending upon the season. Wage rates were:

Mining captain, $145 per month; assistant captain,

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*The expectations of the company's Sudbury manager were not realized. The mine was closed in 1899 after producing 229,379 tons of good-grade ore, reopened in 1908, and closed again in 1909 after producing 5,049 additional tons, or a total of 234,428 tons of ore. It is believed the ore body was cut off by a rock fault.

$90; master mechanic, $100; teamsters, $45. All others were on a daily wage: drill runners, $2.10; miners, $1.75; laborers, $1.60; foremen, $2; watchmen, $1.75; engineers, $2; machinists, $2.25; pumpmen, $2; fitters, $2; firemen, $1.50; blacksmiths, $2.50; assistant blacksmiths, $1.75.

Barring Sundays, the two holidays each year were Christmas Day and Dominion Day. The workday for people in the mines was twelve hours — from 6 A.M. to 6 P.M.; for office workers, ten and one-half hours — from 7:45 A.M. to 6:15 P.M. Overtime was frequent. Transportation between Sudbury and Copper Cliff was by stagecoach. On wheels in summer and on runners in winter, the stagecoach was stove-heated. The round-trip fare was twenty-five cents. Most people preferred to walk along the railroad tracks.

The mine buildings, including the smelters, were of wood, and the metal roofs were so eaten by sulfur that, when repairing them, men had to be careful they did not fall through the rusted iron. Each day wood-cutting crews fanned out farther and farther. Each year the mine and smelter consumed thousands of cords; soon Canadian Copper operations, alone, were burning more than 40,000 cords annually.

Most of the homes were heated by wood and by coal. Kitchen stoves used wood; sparingly, baseburners used coal. Coal was expensive, and the ashes were carefully sifted for partly burned bits and pieces of anthracite.

Every thrifty housewife kept a pig, which roamed free. There was a collection of dogs, and a variety of doghouses. So popular were these doghouses with the pigs on chilly nights that when the dogs came home, after examining all the things a dog considers it imperative to examine, it was to find themselves dispossessed.

The ill-feeling always ended with the coming of winter. With the coming of winter, the pigs were transformed by the alchemy of sharp knives, hot fires, steaming kettles and hickory smoke into hams, chops, sausage, headcheese, spare ribs, bacon, side meat and lard.

Cows roamed free, and around the neck of each was a strap to which was attached a bell. If sleep was disturbed by a restless cow, there was a remedy. The fidgety householder was privileged to get out of bed, go outside, catch the cow and detach the bell.

There were occasional dances. Wearing rubber knee boots, the dancers walked to and from the festivities. The man carried the dancing shoes, and a lighted lantern. There were few sidewalks. Even more occasionally was a shivaree. Always a big event, a shivaree was attended by all who were old enough to beat a dishpan or blow a horn.

Although having more than a thousand inhabitants, drinking water still was peddled, still came from a single spring or from a creek that ran through the town. The spring was unprotected from dogs and pigs and cattle; the creek was a common sewer. The Sudbury *Journal*, an eight-page, five-column newspaper "devoted," as it said in its first issue, "to the development of Nipissing and Algoma districts," made its appearance on March 5, 1891. J. A. Orr was the publisher.

Within the month the newspaper was campaigning to have "pure drinking water piped into the town, or artesian wells and good drinking water secured"; and within three months was publishing letters signed by James Stobie calling for secession of the districts of Algoma and Nipissing from Ontario.

On January 14, 1892, the *Journal* carried "A Notice of Application for Incorporation of the town of Sudbury."

The corner of Durham and Elm Streets was the center of the business district. There were no gas mains and no electric lights, but there were telephones — in all, about a dozen.

There was one in the home of the company doctor. In the office of the company at Copper Cliff there was another. Each of the smelter offices had a telephone; so did each of the mine offices; there was one in the staff residence, and one in the flag station of the Canadian Pacific Railway. Calls were identified by a series of long and short rings. When one telephone rang, so did the rest.

A telephone man was brought in from outside to set up the circuit. One day while he was at work, a stranger stopped to watch and to ask questions. He asked so many questions that the telephone man ran out of information. In compensation, the stranger talked about the ways of electricity, its unsuspected uses, sound waves, and so many related subjects that the telephone man became curious.

"Mister," he said, "if you know so much about these things, why did you send for me? You could have saved your company quite a bit of money by having one of your own men install these telephones just by following your instructions."

"I don't work for the company," returned the stranger.

"You don't? The way you're standing around I took you to be the boss."

The man shook his head, explained he was in Sudbury making "experiments of my own," and walked away.

Before the day was over the installer of telephones

(the records identify him as Bingham) learned the name of the visitor. It was Thomas A. Edison. Interested in nickel for use in storage batteries, the inventor was on one of his periodic trips to the north country.

Away from the settlement, it remained an inhospitable land. Winter came early and stayed long, hiding in its wild beauty sabering winds, deep snows, temperatures of fifty degrees below zero; spring came quickly, investing the birches and poplars and maples in young leaf, and filling the warm air with the sunrise song of birds, but bringing the torture of black flies and the torment of mosquitoes; summer and autumn were soon over. It was winter again.

Yet, whatever the season, prospectors roamed the wilderness of the Shield and brought back proof of its treasures.

Edward Haycock traveled the Lake Timagami region, and brought back news of finding silver, gold, copper, lead and asbestos; Thomas Frood said of the Sault Ste. Marie district, "I have done a great deal of prospecting from the Thessalon to the Mattawa, and from my observations I do not think there is a square mile in that distance [about 140 miles] in which minerals may not be found in appreciable quantities. . . ."

E. B. Borron told of traversing 60,000 square miles "north of the height of land between the Great Lakes and Hudson Bay. . . . The exploration of this land is rendered very difficult, and for the most part impossible, owing to the fact that the face of the country is almost entirely covered by boulders or drift clays, sands and gravel." Borron spoke of finding copper and gold in paying quantities, and attached "special importance to deposits of iron ore, kaolin, lignite and peat," believing they would be found in "inexhaustible quantities."

These were a few of many reports that were brought back, and all agreed, as one said:

> There is no doubt but that the Province of Ontario has great mineral resources which are awaiting development. Not one-tenth of the country has been explored. With a thorough exploration many valuable discoveries should be made, though many of them could not be utilized under existing conditions, such as difficulty of access. . . .

6

A Salesman Goes to Europe

The nineties was a period in which the Orford Copper Company and the Canadian Copper Company were working to find some new method for separating copper and nickel. Of course, this had been done for many years using chemical methods, whereby one metal was dissolved away from the other. What was needed was a quick, inexpensive method of separating the two metals, preferably by some sort of furnace or electrolytic treatment.

Garnier, Hoepfner and David H. Browne appeared on the scene. Each tried his process and each failed. In addition, Browne investigated the Mond process, but decided that the temperature changes in Canada would be too great to make it successful. The solution came from the Orford Copper Company. Here was discovered – or perhaps, in view of later information, rediscovered – a method of separating the nickel-copper matte into a nickel sulfide and a copper sulfide by melting the matte together with nitre cake (acid sodium sulfate) and coke.

The cheapness and convenience of this method put the Orford in a dominant position in nickel refining, but only insofar as it was able to obtain the proper nickel-copper matte, in which field the Canadian Copper Company had the dominant position. But its discovery and application at the Orford, coupled with a contract with the Canadian Copper Company for its supply of matte, put a new light on the world's nickel industry where the Orford, owned by Robert M. Thompson (not related to me), was able to battle successfully for the world market.

Again nickel was in a position which was to be repeated in the future when supply exceeded demand and the need was to obtain its share of the world's nickel market.

This period also introduced one of the world's outstanding nickel metallurgists in the person of Noak Victor Hybinette, who was to become the superintendent of the nickel department of the Orford Copper Company and later the inventor of the Hybinette electrolytic refining process and the technical intelligence behind the British America Nickel Corporation, Limited. He was a great metallurgist of the old-fashioned type. A man of great determination and of unbeaten spirit, he went through a number of successes and a number of reverses during his life which would have destroyed a man of less determination and less resilience.

At the Orford Copper Company he successfully introduced the first melting of nickel in furnaces as distinct from melting in crucibles. A prolific inventor, Hybinette had at one time, so it was said, more than

fifty patents in his own name. When, in 1910, he built a copper-nickel refinery at Kristiansand, in Norway, his Norwegian backers employed his old associate, Anton Grønningsaeter, as an assistant whose main job was to persuade Hybinette to remain in Norway.

The outbreak of World War I interfered. Needing nickel, the British government was instrumental in the taking over of the British America Nickel Corporation, Limited, by Sir James Dunn in 1915. In the process of organization, Dunn obtained the right to use the Hybinette electrolytic refining process in North America. Employed as a consultant, Hybinette joined his new associates, bringing Grønningsaeter with him, and began the building of a refinery at Deschenes, in the province of Quebec, a few miles from Ottawa.

But being a consultant, and being beset by the trials and tribulations of dealing with green help in building and completing a refinery, did not keep Hybinette from inventing. To the end of his days he was always working out ideas and patenting them, and in these years the man who had been hired to persuade him to remain in Norway became his closest friend. "Hybinette was a millionaire at three different times," recalled Anton Grønningsaeter, "and three different times he lost his money in new adventures."

I do not doubt it. The desire to possess millions of dollars never hit Hybinette because it was never aimed where he lived.

j. f. t.

TAKING the position that "the encouragement of industry, not its discouragement, is the office and duty of government," Ontario appointed a commission in 1890 "to inquire into and report upon the mineral resources of the Province, and measures for their development."

The commission held meetings in thirty-seven communities, and examined 164 witnesses. The witnesses were men in every occupation that dealt with mining. Also, the five commissioners visited the iron ranges in Minnesota, the Michigan School of Mines at Houghton, the Columbia School of Mines in New York, the furnaces and steel plants in Pittsburgh, Chattanooga and Birmingham, the laboratory of Thomas A. Edison in Orange, New Jersey, the Sheffield Scientific School, and the furnaces and mines in the vicinity of Port Henry, on Lake Champlain in northern New York.

After agreeing that "notwithstanding the extent and variety of our mineral resources, the statistics . . . show conclusively that in Ontario, as well as elsewhere in the Dominion, the mining industry is making slow progress," the commission turned its attention to ways "to encourage the profitable investment of capital in the mineral lands of the province."

To this end the commissioners hoped "the good sense and liberality of our Governments and our railway companies may . . . overcome the high freight charges in machinery, supplies and ores"; suggested the building of new railroad lines to open new areas; urged the government to recognize "the importance of carefully investigating [our] resources and encouraging, by every legitimate means, their development"; and called for the adoption of legislation to make possible the smelting of ore on a large scale, the refining of matte, and the manufacture of nickel steel within the borders of Canada.

Already, it was the policy of the Canadian Copper Company to do in Canada all that could be done

economically in the processing of nickel and copper ores.

E. D. Peters resigned as general manager of the Sudbury operations in January 1890, and was succeeded by John D. Evans. In September of the same year, and after some correspondence with Thomas A. Edison on ways to separate copper and nickel, the directors employed M. Jules Garnier, discoverer of the nickel deposits in New Caledonia, to find a way to do what Edison said could be done and what, in England, Ludwig Mond was doing.

As a first step in the direction of permitting the Canadian Copper Company to refine its own matte, Garnier built a plant in Copper Cliff, put it into operation on January 23, 1892, and proceeded to bring up the copper and nickel content of the matte to 80 per cent.

The new process did nothing to relieve the company's dependence upon the Orford company, but it was a real technical advance. In addition, it saved money. Formerly, a ton of matte contained 1,200 pounds of iron and sulfur; under the new process it contained 400 pounds. This was a saving of freight charges on 800 pounds in every ton shipped. Despite its nomenclature of iron and sulfur, so far as the Canadian Copper Company was concerned, it was waste.

Under its agreement with Orford, the company was permitted to take the red oxide of iron and nickel produced by the refiner, and reduce it to nickel. Persisting in its hunt for a way to get into the nickel business as a producer of the finished metal, the company transferred Garnier to Cleveland. Here, Garnier went to work in an effort to improve Orford's methods.

The new plant, which was built in the city's outskirts, was designed by Garnier. It contained a cupola furnace with a hot-blast stove, a set of gas producers, a Siemens open-hearth furnace, and a regenerative furnace, roasting furnaces, etc. The hot-blast stove, a brick structure, was protected from rain and snow by a galvanized iron roof.

To support the roof, a brick wall thirteen inches thick with eighteen-inch buttresses was built around, and three feet away from, the stove. The Siemens furnaces, installed on the second floor of a large brick building, were well designed but the beams which held up the second floor were embedded in the brickwork of the regenerators. As a result, when the regenerators were heated, the entire second floor was lifted.

Garnier was spending a lot of money, so much and with such small results that David H. Browne, chemist at Copper Cliff, was called to Cleveland. Accompanied by H. P. McIntosh, secretary of the company, he went to the plant. Afterwards, Browne wrote about the visit:

> As we reached the gate, I was surprised by a series of explosions from the furnace building, and we sprinted toward the scene of the trouble. On the second floor of the building was a Siemens furnace full of melted nickel. It was said to be refined. At any rate, M. Garnier wished to take it out of the furnace and pour it into water to form shot.
>
> At the back of the furnace was a wooden platform on which stood a pallid and perturbed workman holding an iron ladle with a long handle. This ladle was about the size of a derby hat, and a handle was hung from a rope which went over a pulley in the roof and was pulled up by another workman around the corner. A third man was in charge of another rope

> by which he hoisted a small brick door or opening into the furnace.
>
> M. Garnier explained that the explosions were nothing worth consideration, and the process was resumed. Slowly the brick door rose, exposing the bath of nickel. Slowly the ropes were manipulated and a hatful of nickel was removed from the furnace. Two men to one side crossed themselves devoutly, and taking hold of a long coffin-shaped board plunged it into a tank of water, and commenced to agitate it back and forth. The ladle swung around, tipped over into the water, and another explosion shook the windows. . . .

Garnier worked hard, but his ideas and his hard work led the company no closer to the satisfaction of making its own refined nickel. Not long afterward Garnier was called back to France, but not before his personal charm had made him as popular in Cleveland as he had been in Sudbury.

Browne, upon whose recommendation Garnier was hired by the Canadian Copper Company, remembered him fondly, and often recalled their days together in Sudbury. "Suave and courteous, the typical French gentleman with the tri-color Ribbon of Honor in his frock coat," the chemist remembered, "we used to have our lunch together in the laboratory. On these occasions Garnier always produced a bottle of claret from his own vineyard in Marseilles.

" 'You see, Monsieur Browne,' he would say in delightfully accented language I shall not try to reconstruct, 'at the hotel where I stay the tea is very bad, and the coffee is ex-er-crable. If I drink the wine in the morning, the people will look at me, and think I am one drunkard. So the other day, I think, ah! I will try the chocolate. So I call the garçon, and the garçon bring the chocolate, and what you think?

" 'He pour the chocolate so — pop! — there goes the cockroach. You know the cockroach, Monsieur Browne, the little insect that infest the kitchen. That makes me very sick, and I say "Take That Away!" But I think I try him once more, so I call the garçon, and the garçon pours the chocolate — pop! — there goes the same damn cockroach. I now drink the wine.' "

Dr. Carl Hoepfner succeeded Garnier. Hoepfner brought with him from Germany a number of patents on an electrolytic process for refining nickel. In his process, Hoepfner used chlorine to dissolve the matte, and employed tanks made of wood, with partitions of nitro-cellulose cloth. The attending stench was sensational.

After spending about $15,000 on a number of experiments, the process was discarded. Hoepfner was released, and the company was thrown back on its own resources.

From 1893 to 1897, the company carried on its investigations on a small scale. Heap roasting continued. Part of the furnace matte, containing 20 to 25 per cent copper, 18 to 23 per cent nickel, and 25 to 35 per cent iron, was resmelted in a cupola furnace and Bessemerized to about 40 per cent nickel and 45 per cent copper. The Bessemer matte was sent to Cleveland where a "50-50" alloy was produced. For a time, there was a reasonably good market for this alloy. When the demand ceased, which it did, the practice of Bessemerizing the ore was discontinued.

It was clear that something cheaper, something more expeditious, and something in the way of a better process had to be found if the company was to survive. A way was

found and, of course, the company survived, but not in the form its directors hoped. It was a process that was found by Orford.

When the Orford people realized in 1886 that the matte contained both copper and nickel they started to find methods of separating these same two metals. At first, they worked on the well-known process of dissolving the copper out with sulfuric acid and then converting the nickel sulfide to oxide and reducing it to metal. But they were always trying other methods where the separation might be made by a melting process and, with this in mind, many experimental charges were melted in crucibles using various additions.

From previous experience, when he had worked for the Tennants in Glasgow, William Gibb, head sampler at Orford, suggested that nitre cake (acid sodium sulfate) be used. This was a practical suggestion, since it was a regular product of the adjoining Bergenport Chemical Works. In the trade, this salt was known by its nickname of Sally Nixon derived from its older — possibly alchemist — name of *sal enixum*.

When a full crucible of matte, nitre cake and coke was melted and allowed to cool in the crucible, a surprising phenomenon occurred. The previously homogeneous matte separated into two layers, a dark one on top and a shiny one on the bottom. Analysis showed that there had been a separation of nickel and copper, with most of the copper being concentrated in the "tops" and most of the nickel in the "bottoms." Thus, through a very simple fusion with readily obtainable materials, nickel and copper were roughly separated. Although it was not a complete separation, thus was born the commonly known "tops and bottoms," or Orford Process.

It was William Gibb who hit upon the solution. Gibb suggested that the bottom part be resmelted, and a second separation made. This was done — nine times. After the ninth smelting, they had a fragment holding great promise. Many experiments were made. One difficulty after the other was flushed away until they produced nickel of good grade.

Thompson applied for a patent on what he called the Orford Process and was informed that, in 1877, a shoemaker living in Hartford, Connecticut, had applied for, and was given, a patent based on much the same idea. The shoemaker's name was William B. Tatro. Thompson went to Hartford. Here he learned a number of things.

There was a small vein of nickel ore in Connecticut and Tatro, being of inventive mind, had experimented. Mixing the ore with different chemicals, and using a kitchen stove in place of a furnace, the shoemaker found a way to produce an alkaline sulfide that caused the same separation as the "Sally Nixon" used at Orford. Thompson also learned that Tatro was dead, that his patent had been transferred to a small company, and that nearly all the stockholders also were dead.

Thompson revived the company and bought its patent rights. Improvements followed, both on Tatro's ideas and on the Orford findings. In 1893 patents were obtained in the United States and in many other countries, excepting Germany. From Germany came the word that the results claimed for the process were unobtainable. Thompson invited the doubters to see for themselves and offered to pay the expenses of an investigating committee. The offer was declined.

The origin of the process was long in dispute. During the 1800's various patents had been granted by patent

offices on metallurgical procedures in which an alkaline agent was employed, although used for different purposes. All might have found scientific teachings pertaining to the Orford Process — just as Thompson could have found the same description — had they examined the pages of a Swedish technical journal published in the previous century, in the year of 1776.

In that year Gust. von Engestrom, Swedish chemist, published his experiments into the metallurgy of paitung, as it is called in Chinese, and which means "white copper." Describing the metal as "rather like silver," von Engestrom wrote:

> By melting the rough metal with Hepar sulphuris I got two separate metals, one that was red and forgeable was real copper, and the other was grayish white, brittle, and with a fracture like that of steel. When further experiments were made, the last-mentioned metal turned out to be real nickel containing a little cobalt. The proportions of nickel and copper were about 5 or 6 to 13 or 14.

Continuing, the chemist said:

> Some alloying experiments would certainly show in what proportion these three metals [copper, nickel and zinc] ought to be mixed in order to form a real paitung. My intention was to make it of Swedish nickel; as this, however, contains a good deal of arsenic, and as other affairs have prevented me from purifying the same, it has not come off yet. At any rate I hope that this article will be of some use to those who have the opportunity and who care to amuse themselves with this problem, the solving of which may be of public and private benefit.

So, there it was, all spelled out for the English, the Germans, the Swedes, the Norwegians, the French and the world — but especially for Thompson and his people at Orford who were working their heads off in a field already plowed and planted, rediscovering a process already known for more than one hundred years.

With the Orford Process in his pocket, Thompson became the big man in nickel. In the same pocket was a contract to refine, and to sell, the entire output of the Canadian Copper Company. For refining it, he was to receive a small toll; for selling it, he was to get half the profits. Unlike Wharton, whom he was to displace as the foremost refiner, and to whom nickel was a passion, Thompson had several interests. Two of Thompson's interests were copper and cotton, in each of which he was a large speculator. His willingness to risk and his capacity for speculation brought him the nicknames of King Copper and King Cotton. Practical, hardheaded and shrewd, his talent for work was unbelievable. Having picked up the best nickel account in the United States — the Navy — he began looking at the European market. Breaking into it would not be easy, and he knew it.

In the first place, French nickel was superior to the Orford product. In the second place, the European market was controlled by Rothschild's Société Le Nickel into which, in 1880, had been put the several companies operating in New Caledonia. Le Nickel had refineries in Kirkintilloch, Scotland; Erdington, England; Iserlohn, Germany; and Le Havre, France.

Boldly in 1892, Thompson sailed for Europe, and returned to New York, recalling:

"I wanted to dispose of 500,000 pounds of nickel. Nickel was then selling at 60 cents a pound. I offered to

sell this nickel at 50 cents a pound, which allowed a margin of 10 cents . . . and they declined. I promptly went to Krupp, at Berndorf, and sold to him at 50 cents."

A year later Thompson was in Europe again. This time he had a million pounds of nickel to sell. He went to the Rothschilds, and offered his product at about thirty-seven cents a pound. They shook their heads. Thompson then went to Basse & Selve, smelters of nickel in Schwarzenstein, Germany, and submitted the same price. He found some interest. Just as quickly, he found himself in a round of price-cutting. Before the year was over nickel was selling for less than twenty-five cents a pound.

In 1895, Thompson supplied a large part of the world market and was able to say, and did, that "Société Le Nickel had finally arrived at the opinion that there was something in Canadian nickel."

Singularly, in the rough-and-tumble struggle, Thompson and Baron Adolphe de Rothschild became friends. In the course of the struggle, Thompson crossed the Atlantic thirteen times in one year. He had learned it was a mistake to make a quotation on nickel to a prospective European customer. The prospect was able to save money by taking the quotation to Le Nickel. It always shaded the price. Thompson learned quickly. Thereafter, when invited to submit a bid, he jumped on the first steamship, appeared in person, asked for an offer and, almost always, made the sale.

This was the sort of competition the Rothschilds appreciated — and understood. It brought casualties. First to go among the Sudbury companies was the Drury Nickel Company. The cost of doing business was too much for the company's income. It suspended operations in 1892, resumed in 1893, and gave up entirely within a short time thereafter. In business four years, the Dominion Mineral Company produced about 100,000 tons of ore before market conditions and differences of opinion within its management halted operations.

In the summer of 1894, after losing approximately $400,000, H. H. Vivian & Co. closed up shop in Canada. About 10,000 tons of ore were left in the roast yard. Sometime afterward the ore was sold to Joseph Wharton. Various reasons were advanced for the withdrawal. General economic conditions were partly responsible. The small market for nickel was partly responsible. A third reason, so it was said, was lack of co-operation between the Vivians' offices, the branch office in Sudbury and the home office in Swansea, Wales. The withdrawal of Vivian shook the industry and, with the industry, it shook Canada. The purchase of the Murray mine in 1889 by the metallurgical firm of world-wide reputation was an event of major importance. Confidently it had been prophesied that the resources and experience of the Vivians would bring a long and continuing period of development of Canada's mineral resources.

It was while Drury, Vivian and Dominion Mineral were trying to establish themselves in Sudbury that a young Swede from the slag heaps of his native Falun came into the Orford company's office in downtown New York, and asked to see Robert M. Thompson.

The young man's name was Noak Victor Hybinette. Of French Walloon ancestry, Hybinette's earliest memories were of furnaces and mines whose slag heaps were his playground. More than two hundred years before, his ancestors had gone to Sweden from France to produce iron. From iron his forebears had gone into the pro-

duction of other metals with the result that in 1816 his grandfather arrived in Falun, site of Stora Kopparbergs Bergslag, a metallurgical plant whose principal concern was copper. Hybinette's father married the daughter of one of the owners of the company, so that when the young man completed his technical training in June 1887, he went into the plant as assistant to Henrik Munktell, general manager of its copper works.

Anxious to develop a process to extract nickel from the ore of the Slattberg mine, located a few miles north of Falun, Munktell put Hybinette in charge of a series of experiments. The experiments were so successful that Munktell organized a separate company and built a smelter in Hommelvik, Norway. Hybinette was made superintendent of the new plant, which was located where it was because the ores of Norway were richer than the Swedish ores.

After starting well, the company began to have its troubles. So did Hybinette. The price of nickel dropped from eighty cents to sixty cents a pound. Seeking to improve his process, Hybinette visited nickel plants in Germany and in England, studied their methods, and returned to Hommelvik where he made changes that enabled the company to make a little money.

One day in the autumn of 1891, while reading the *Engineering and Mining Journal,* Hybinette saw an article telling of the signing of a contract between the United States Navy and the Orford Copper Company for the delivery of 500 tons of nickel a year for five years.

It did not take Hybinette long to make up his mind. He went to his employers and advised them to close their plant (which they did) "while I go over to America to see what the Orford people are doing."

Arriving in New York in the spring of 1892, Hybinette learned that Thompson was not in the city. Rather than wait for a week or two, he went to Sudbury where he dropped in on different companies, looked over their operations, and went back to New York, unimpressed. This time, after waiting a few minutes, he was ushered into Thompson's presence.

Presenting a letter of introduction from Paul Johnson, a Swedish metallurgist who was a personal friend of Thompson, Hybinette had no trouble interesting the president of the Orford company. Thompson sent him to John L. Thomson, general manager at Constable Hook. The following day Hybinette reported back to Thompson expecting to get a job. Instead, he heard Thompson say:

"I am very sorry, my young friend, but Mr. Thomson is in full charge and I cannot dictate to him. He has just told me that you have come here to study our process, and return to Norway."

Hybinette's vigorous denial made no impression, but Thompson did relent enough to suggest that the young Swede call on him "some time in the future. Perhaps we can still come together."

Deeply disappointed, and with but a few dollars in his pocket, Hybinette went to Ledoux and Company, who did all the weighing, sampling and assaying for the Orford Copper Company. Here he talked with Dr. A. R. Ledoux, told him his story, and was hired as a laboratory worker at $18 a week. The head weighmaster at Constable Hook came to the laboratory once weekly and reported, in full, on happenings of the week.

It was not long before Hybinette was pretty well informed regarding the affairs of Robert M. Thompson. By careful listening and discreet questioning he

learned that the Orford Process included repeated smeltings, called "treatments"; that the salts contained in the bottoms were washed (leached) from the oxide before roasting, and that the material so produced contained 70 to 72 per cent nickel and cobalt, 1 per cent iron, 1 per cent copper, 1 per cent arsenic, 1 per cent antimony, some sulfur and some silica.

Not greatly taken by the process, Hybinette familiarized himself with the patents which were applied for by R. M. Thompson, John L. Thomson and Charles Bartlett. Without much trouble, he learned that none of the three men had technical training, that Bartlett was a foreman at Orford, and that the real inventor of the process was William Gibb. Still listening, he heard that Thompson and the company he owned were not in good shape financially.

A less tenacious man could scarcely have done what Hybinette did. Anticipating the time when armor plate makers would be required to produce a better product (which meant they would have to have better nickel) Hybinette obtained samples of the Orford oxide. It was not long before he found a way to remove almost all the copper, arsenic, antimony and sulfur.

Hybinette went to Thompson and told of his work at Ledoux's laboratory, of his experiments with the Orford oxide, and closed his recital with these words: "Your product is rotten, and if you knew how to make it better you certainly would."

Instead of taking offense, Thompson burst into a roar of laughter, asked a few questions, and suggested to Hybinette that he "come back in a few days."

The following afternoon Dr. Ledoux called Hybinette into his office, questioned him closely on events of the preceding day, told him Thompson was planning to hire him, and concluded by saying: "I want to give you some advice. Thompson is a shrewd trader; and if he can get something for nothing, he will take it."

As Ledoux predicted, Thompson sent for Hybinette the next day, but did not offer him a job. Instead, he gave Hybinette a five-pound sample of oxide to refine. Hybinette objected, saying the material had been heated to such a high temperature that nothing could be done with it. Thompson refused to listen. Hybinette departed, carrying the sample.

Alone in the Ledoux laboratory on the following day, which was Sunday, Hybinette experimented with the sample, and concluded "that the only thing that could be done with it would be to volatilize [vaporize] some arsenic and antimony as chlorides. . . . Monday morning Mr. Peek [R. L. Peek, Hybinette's superior] could not get any draft in his muffle furnace and, on inspecting it, found all flues choked with some condensation products. I had to confess what I had done, and was properly reprimanded."

Continuing, Hybinette recalled: "I found that I had volatilized practically all arsenic and antimony, and some copper as well. I returned the sample, and the next thing I knew the oxide shipments started to come through with very much reduced arsenic and antimony. Later on I was told the sample had been found to contain some chlorides, and they had started to add rock salt to the sulphide during the roasting."

This was the first of several improvements suggested or made by Hybinette, but it was not until the end of January 1893, several months after Ledoux had made his prediction, that Thompson offered him a job. In making the offer, Thompson said he had leased an old foundry

in Bayonne, New Jersey, and promised Hybinette he would "be given a free hand to build furnaces, and start production of nickel metal."

In explaining his reason for renting a vacant foundry building, Thompson told Hybinette he had been forced to do this because "you are not wanted in the Orford Works," and fixed the salary at $125 a month.

Promptly, Hybinette pointed out that he "got much more in Norway, and was getting nearly as much from Ledoux." Thompson was not won over, but did promise, "I'll pay you more after you demonstrate your ability."

The first thing Hybinette did was to build a small oil-burning furnace fired by what is known as a Russian pan burner, that is, an open pan supplied by a service of fuel oil. After ignition the flames from the burning oil were pulled into and through the furnace by the natural draft of a stack.

By properly controlling the oil and air supply, most of the combustion could be forced to occur at any predetermined part of the furnace. Although extremely wasteful of thermal units, at the time it was unexcelled as a direct producer of high temperatures. More amused than impressed, few days went by when John L. Thomson failed to drop in, and to twit Hybinette about trying to produce metallic nickel "in an oil stove fired with a kerosene lamp."

The time came when the Orford general manager was shown several hundred pounds of nickel shot. Greatly chagrined, he confessed: "Yesterday I told Mr. Thompson that you had built a miserable little oil stove with a little kerosene lamp in it and expect to melt nickel in it. Now I have to go back, and tell him that you did melt it."

Visibly gratified, Hybinette reached for Thomson's hand. The two men became friends.

The only trouble Hybinette had with the furnace, which had a capacity of 200 pounds of nickel, was with the pans. These filled up with coke every few hours. Devising a box four inches deep that kept the coke from baking together, and which permitted its periodic removal, Hybinette built a second furnace for the Balbach Smelting and Refining Company of Newark, New Jersey. It worked as well for them as it did for him. Not only that, they gave him a bonus of two hundred and fifty dollars. He tried to get a patent, but failed. Nevertheless, Hanson & Van Winkle, of Newark, used his device and paid him royalties amounting to a few hundred dollars for three months.

The order from Balbach was especially interesting to Hybinette. The company was experimenting with an electrolytic nickel refining process that was being closely watched by Thompson — so closely, that in the spring of 1894 Orford contracted for Balbach to refine whatever amount of nickel was needed to satisfy the nickel (German) silver trade.

This was a market that required a much better grade of nickel than Orford supplied. For refining it, Balbach was paid ten cents per pound of cathode produced. Orford furnished the anodes, and took back all scrap and by-product.

The tonnage of fine nickel turned out by Balbach was about 30,000 pounds a month, which represented about one-tenth of the total production of nickel in all forms. The process was secret, was costly, was quite crude, and used the electrolyte patented by Edward Weston, famous electrical inventor, in 1878. After three years, and because

of its expense, Thompson dropped the process, and turned over the business to Le Nickel.

As might be expected, there were those at the Canadian Copper Company who were not happy over Thompson's success in the nickel market. The fact that they were supplying the matte that provided the nickel Thompson was selling did not lessen the unhappiness.

They knew that, when alone, copper and nickel each was worth more than when they were together. They also knew that Thompson could leave them high and dry any time he chose not to renew the contract between them.

7

Mond Comes to Canada

IN 1894, and at the request of the directors of the Canadian Copper Company, David H. Browne was at Copper Cliff working, as he said, "on a process of our own for refining nickel." Browne realized, and so did the directors, that the complex Sudbury ores imposed a heavy burden on a metallurgist.

In the same year of 1894, the Copper Cliff mine produced 24,000 tons of ore, the Evans about 35,000 tons, and the Stobie about 18,000 tons, altogether a total of approximately 77,000 tons of ore. Canadian nickel production at the time amounted to approximately 45 per cent of the world's production. Apparently satisfied that Browne would not be able to develop "a process of our own" within the year, the directors met in Cleveland on September 25, 1894, to transact two pieces of business.

They decided to renew the contract with the Orford Copper Company, and they declared a dividend of one dollar a share on the stock. It was the first dividend in the history of the company.

At Sudbury, furnaces were tucked in wherever there was room, wherever the ground permitted, and whenever the demand justified it. There were no labor-saving devices, all the furnaces being fed by what was labeled the "Patent English Wheel Barrow System." When the first ore was roasted in 1888, the cost was twenty cents a ton; in 1894, the cost was seventeen cents a ton. The roast piles were large, and burned from six to nine months.

In the roast yard was a workingman named Santoma, whose job it was to dynamite the roasted piles to loosen them up for the shovelers. Browne, the chemist, also was Browne, the attending physician in matters of first aid. Browne remembered that Santoma "was exceedingly careless in his use of explosives, his method being to make a hole in the pile, then retire to a shanty under the trestle where he kept his dynamite.

"In walking over the trestle to the laboratory I often saw him in winter time come out of the shack with a stick of dynamite under his arm to keep it warm. He had the fuse lit, and smoldering. He pushed the dynamite into the hole, tamped in the clay, and ran for a protecting timber. I was usually speeding for the laboratory with my coat tails horizontal before the explosion occurred."

Often the extra duties were demanding, but they did not keep the chemist's mind from speculating about how to separate nickel from its ores. A frontiersman in science, he was confirming what every frontiersman knows, that frontiers are never easy, and never free. The same challenge that summoned Hybinette summoned Browne. The challenge was to find an electrolytic process for the separation of nickel from combinations of nickel with other metals.

Browne experimented through 1894, through 1895, and almost through 1896 when, becoming interested in the Mond nickel carbonyl process, the directors sent Browne to England to study what Mond was doing, and how it was being done. Ludwig Mond, too, was a frontiersman.

Of German origin, he was born in 1839 in Cassel, in the Grand Duchy of Hesse. In 1862, with a well-schooled, well-disciplined and inquiring mind; with scars of saber duels at Heidelberg on his face and chest; with the equivalent of fifteen English pounds in his pocket; and, as he recalled, with a determination to "see which is the greater, my idiocy or my energy," he took a night boat from Rotterdam to London. For the most part, the other passengers were cattle bound for the slaughter pens of England.

Twenty-five years later, having established, in partnership with John Brunner, a large and profitable chemical business out of Ernest Solvay's ammonia soda process, Mond again was in search of a way to recover valuable elements from the waste products of his plant.

It was the same curiosity that brought a boy's questions as to what became of the wool when there was a hole in his stocking; or when the boy was a youth at the University of Heidelberg and his inquisitiveness drew the attention of the eminent Robert Wilhelm Bunsen, who was his instructor in chemistry.

And now, in 1889, his home, "The Poplars," Avenue Road, St. John's Wood, north of Regent's Park, was an

ornate mansion set back from the road. Behind the mansion was a wide lawn, shaded by a huge chestnut tree, and behind the lawn were stables which Mond promptly converted into the one tool he had to have close by, wherever he was. That tool was a research laboratory.

It was in this laboratory in October 1889 that Mond, Carl Langer, his personal assistant and a young Austrian, along with Friedrich Quincke, a German scientist, were trying to find a way to produce bleaching powder as a by-product of the "ammonia-soda" process, as it was called — and found something else.

The *something else* was nickel carbonyl.

The discovery was announced in August 1890 in a paper presented to the British Chemical Society. Entitled "Action of Carbon Monoxide on Nickel," and signed by Ludwig Mond, Dr. Carl Langer and Dr. Friedrich Quincke, the paper told of the forming of a gaseous compound of carbon monoxide and nickel; and in matter-of-fact language recited how the signers "noticed that the flame of a Bunsen burner into which the escaping gas was introduced became highly luminous, and when we heated the tube through which the gas passed, we obtained a metallic mirror which proved to be nickel mixed with a small quantity of carbon. . . ."

In his book, *The Life of Ludwig Mond,** J. M. Cohen wrote of the discovery this way:

> . . . In the course of these experiments a combustion tube was set up in which finely divided nickel was treated with pure carbon monoxide made by the action of sulphuric acid on a formate. To keep the poisonous carbon monoxide out of the atmosphere

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of the laboratory, the tail-gases from the combustion tube were passed through a glass jet and there burned. The experiment was started each morning and shut down each night, the nickel being allowed to cool off in the stream of carbon monoxide before the whole apparatus was shut down.

One evening in 1889, however, the assistant who usually remained behind to close down the experiment, had gone home early, and Langer himself was waiting for the flame to die down and the last of the carbon monoxide to be burnt before locking up. It was the first time that he had done so, and he was quite unprepared for what he saw. For as the apparatus cooled he saw, to his great surprise, the flame of the jet grow luminous and increase in brightness until the temperature fell below the boiling point of water, when the flame faded again. Furthermore, from its usual lambent blue the flame had turned a sickly green.

Ludwig Mond was called at once to witness the strange phenomenon and together they stared in silent wonder. At first both thought of the arsenic that might be present in the sulphuric acid. Arsenic was known to form a volatile hydride that would tinge the flame with green. But that was readily tested — a cold porcelain tile was thrust into the flame and was immediately coated with a shiny mirror, not unlike, but significantly different from, the spots left by arsenic in Marsh's test; and when the neck of the combustion tube was heated, a bright mirror formed on the glass and the luminosity of the flame disappeared.

The mirrors were analyzed and appeared to be

nickel, but such was the improbability of so heavy a metal as nickel forming a volatile compound that Ludwig would not believe his own tests, and postulated an unknown element in the nickel. Both the carbon monoxide and the nickel were then purified as carefully as possible, but still the phenomenon occurred. It was not, one feels, until the gaseous nickel carbonyl had actually been frozen to a mass of needle-shaped crystals that Ludwig could really believe that he had, in Lord Kelvin's words, "given wings to a heavy metal."

Metallurgically speaking, it was (and is) a beautiful process. It took a solid, converted it into a gas, and reconverted it into a solid, causing Mond to observe: "It can no longer be stated that Necessity is the mother of Invention; but I think it may truly be said that the steady, methodical investigation of natural phenomena is the father of industrial progress."

Following the discovery, Mond offered the process to nickel refiners in England, was turned down, and then offered John Brunner a partnership in the new enterprise. Brunner was preoccupied with politics, so that when he sought participation it was too late. Mond had given Langer a substantial interest for his contribution in making a success of the carbonyl process. It was this acknowledgment to Langer that kept Mond from offering the full partnership Brunner wanted. The new enterprise was located in a wooden shed Mond had built on the property of Henry Wiggin & Company at Smethwick, near Birmingham.

This was a natural location for the pilot plant. Henry

Wiggin & Company were nickel refiners. Their experience would be useful, and handy.

Three years, and more, were needed to find answers to just some of the production problems. Mond still was not sure he wanted to go into a new business venture. He was fifty-three years old. Success in business already was his. While he was making up his mind he engaged Bernard Mohr, a mining engineer, to find out what he could about the world's nickel deposits, and to inspect the ores. In his report Mohr gave the nod to Sudbury ores.

This was encouraging, for the Canadian ores seemed to be the only ones available in quantities large enough to make refining profitable. But, there also were discouraging passages in the report. Mohr reported that (1) the Orford company had developed a process that separated nickel and copper; (2) a state of depression existed in the industry; (3) matte was stacked up in the Sudbury yards; and (4) several Canadian mining companies had ceased operations.

Added to this melancholy information was the fact, known to Mond, that his process, in its existing state of development, was able to extract only about half the nickel in the Sudbury matte. Mond was not dissuaded. He saw the obstacles as timesavers that gave Langer and himself, principally Langer, further opportunity to straighten out the processing difficulties that remained.

By 1896, Mond had many of the technical processing difficulties well licked. Through Wiggin he submitted the process to Orford. Robert M. Thompson was interested, but not enough interested to accept any of the proposals that were made. It was while Thompson was dallying that the Canadian Copper Company sent Browne to England.

Impressed, Browne wrote a report on the strength of

which the Canadian Company took an option to buy the patents, and process, for $1,500,000.

Browne returned to Smethwick in 1897 for purposes of further studying the carbonyl process and watching its operations in extracting and separating the various metals in the Sudbury ore. With these purposes in mind, he had about seventy-five tons of Bessemer matte delivered to the Mond plant, and remained in England for almost a year.

Then, and as his wife said, "it almost broke Dave's heart to turn down the process, but he had to do it." There were personal, and business, reasons for Browne's regret. During their stay in England, Browne and his wife had become good friends of Carl Langer and his wife. Each couple had a son. Each son was about the same age. They studied together and played together. That was the personal reason. For business reasons, Browne wanted the Canadian Copper Company to be able to produce its own finished metals.

But he was far from being satisfied that the process was ready for adoption. Mechanical difficulties remained unsolved. The gas, which was very poisonous, still leaked. He was sure years of effort would be required before this danger would be removed, and work made safe — as it later became. He believed the skilled labor necessary to man the intricate apparatus was not available, and he was confident that Sudbury winters were too rigorous for the process.*

Another handicap, in Browne's mind, was the fact that all the copper was produced as copper sulfate. "This," he reported, "was sold for use in the vineyards on the

*In 1915, The Mond Nickel Company, Limited, filed a memorandum entitled "Why Refining in Canada by Mond Process Is Not Feasible." Substantially, the reasons given were the same as stated by Browne. The memorandum was filed with the Ontario Nickel Commission.

continent as a poison for scale and phyloxera." This did not appear to be a sufficient outlet for the copper, and for the directors of the Canadian company this point turned the scale against the adoption of the Mond process.

Negotiations between Canadian Copper and Mond lasted more than two years. They would have lasted longer, and they might have ended in agreement had the Copper company been less sure of its position. Confident it held the winning trump through its ownership of nickel deposits, it rejected the claims Mond made for his process — and asked for better terms. Mond did not offer better terms. He accepted the rejection, and sent Langer and Mohr to Sudbury.

It was a careful decision. Before making it, and knowing that Samuel J. Ritchie was involved in litigation with the Canadian Copper Company, he wrote Ritchie many letters in which he sought advice on many subjects, including Sudbury ores. It was advice Ritchie was glad to give.

In sending Langer and Mohr to Sudbury, Mond impressed upon his representatives the importance of locating not just a nickel deposit, but a nickel deposit that would assure a minimum production of one thousand tons of refined nickel a year, for a period of years. If he could be sure of having such a minimum production for a period of years, Mond was equally sure he would have a profitable company.

A lot of work had to be done before he was satisfied.

One of Canada's leading geologists was employed to make a survey to locate, insofar as it was possible, hidden mineral resources. He found little that was not known. One of the world's leading mining engineers was employed to check the findings of Mohr. The expert disagreed with

Mohr's estimate of a probable 200,000 tons of ore in the deposit under consideration, and changed it to 100,000 tons as a maximum.

Mond realized early, as his son, Alfred Mond (later Lord Melchett) testified in hearings of the Ontario Nickel Commission in 1916, that the Sudbury mines were not like most mines — "they are very erratic bodies, and very difficult to estimate." At the time the common impression was that the maximum depth of the deposits was 500 feet. Mond never learned how deep deposits sometimes go. Nor has anyone. In the Creighton mine, drills are down more than 6,700 feet. How much deeper can they go? Who knows?

The deposit that particularly interested Langer and Mohr was owned by Alexander McIntyre, Joseph Riopelle and Rinaldo McConnell, a timber cruiser turned prospector, but had been discovered by Henry Ranger. At the time of discovery, Ranger was prospecting for minerals, was on McConnell's payroll, and was eyeing and fingering rock formations in Denison township. He reported his find and on October 26, 1886, McConnell filed on 1,165 acres. The patent was issued January 27, 1887. McConnell kept one half interest, and assigned the other half to McIntyre and Riopelle.

In January 1899, McConnell was invited to England to meet Ludwig Mond. He went but, by the time he arrived, Mond was in Rome. After a number of discussions in London with Alfred Mond, McConnell went to Rome.

The meeting that followed must have been a remembered moment in the life of Ludwig Mond — and in the life of Rinaldo McConnell.

They met in the Palazzo Zuccari, Mond's winter home, with its priceless paintings, its magnificent library, its music room where gathered the great and the famous of Italy, its guest rooms which heard the voices of D'Annunzio and Eleanora Duse, its balcony from which could be seen the dome of St. Peter's — and dominating the household, short-legged, big-bodied, baggy-trousered, velvet-coated, grim-faced Ludwig Mond, his feet thrust truculently forward, a cape about his shoulders. Already, he was a man of authority.

Facing him, a timber cruiser whose paintings were on the broad canvas of the eastern hills when the bright fingers of morning reached across the sky; whose music room was a high hemlock from which whispered the soft, silvery song of a hermit thrush; whose banquet hall was a campfire on the shore of Nipissing; whose books were stands of poplar, jack pine and birch, and the sands and gravels, drift clays and rocks of the Canadian Shield — this was Rinaldo McConnell, into whose eyes Ludwig Mond, in characteristic inspection, had stared while acknowledging the introduction.

The men soon understood each other.

It was only a little while before McConnell was back in the north country mapping out a town on the Sault branch of the Canadian Pacific Railway, twenty-two miles west of Sudbury, building roads, clearing the land, locating a site for a smelter, sketching an aerial tramway from the mine to the smelter, laying out plans for the development of water power, and supervising the work of opening the mine.

Mond had agreed to buy the property subject to one condition. If, after five months' investigation, it could be demonstrated that there were two hundred thousand tons of ore "with at least five per cent of nickel, plus copper," Mond would pay $200,000 for the deposit, but would be

allowed to deduct the costs of the investigation from the purchase price.

Before the summer of 1899 was over, Mond owned the property. He renamed it the Victoria mine.

But, while Mond still was studying the reports of Langer and Mohr, preparatory to buying the property, Browne was in Cleveland picking up the loose equations in his long-dreamed electrolytic process for refining nickel. This was the work that was interrupted when he was sent to England. At his elbow were the facilities used by Garnier and Hoepfner; and almost within walking distance were the facilities of the Case School of Applied Science.

Briefly, the process on which Browne was working involved electrolysis of salt to produce two reagents, chlorine and caustic soda. The one was used to dissolve powdered metal (reduced from roasted matte); the other was used to precipitate nickel from the purified solution. In the purification most of the copper was electroplated from the chloride liquor in a series of tanks supplied with anodes of Bessemer matte, or of copper nickel made from the matte.

Sodium sulfide was used to precipitate the last of the copper from solution. Progressively, iron then was removed by adding soda solution to the liquor after oxidation with chlorine. The last nickel precipitate was run through a drier and finished at red heat, yielding a nickel oxide which was found to require further treatment to reduce an unanticipated sulfur content. After much study and experimentation, Browne learned it was a sulfur content that was supplied by the local water.

Browne was making so much progress with his experiments, and the future looked so promising, that on February 26, 1898, the directors of the Canadian Copper Company met and agreed "to acquire . . . copper-nickel deposits belonging to The Anglo-American Iron Company, if they can be acquired for $680,000.00, payable in the company's stock at par; and that we recommend the increase of this company's stock $680,000.00 for the above purpose."

The Anglo-American shareholders approved the exchange of stock, but not on the suggested terms. On May 11, at a special meeting, the shareholders raised the price to $850,000, payable in stock of the Canadian Copper Company. Even so, strong objections to the sale were raised by a minority group which was sympathetic to Samuel J. Ritchie.

Four years previously, or in 1894, Ohio courts had ordered Ritchie to repay the money he owed his former fellow directors. In the event of failure to pay, the courts ordered that the collateral be sold to satisfy the debtors. When Ritchie failed to meet his obligations, the directors transferred the collateral to their own accounts, and canceled the debt. Incensed because he received nothing for his stock, although yearly dividends averaging somewhat less than six dollars a share were paid in 1894, 1895, 1896, and 1897, Ritchie filed a series of new suits, and while the suits were awaiting disposal, he began a bitter publicity campaign against the Ohio group.

In a long series of pamphlets, newspaper articles and newspaper interviews, Ritchie appealed to the prejudices of the Canadian people by (1) claiming that the Canadian Copper Company received its charter on its promise to refine its ores in Canada; (2) arguing that not only was it economically possible to refine the ores in Canada, but

to do so was a national necessity; and (3) insisting that the Canadian Copper Company had hampered the development of the Canadian nickel steel industry by unfair practices.

The arguments were not new. Nor was the question of making the refining of nickel an undertaking to keep within the borders of Canada a matter of partisan politics. Almost from the time of discovery the subject was one of general discussion in Parliament.

There was the 1891 effort of the Ontario legislature to interest the British government in a joint effort to establish nickel refineries and nickel steel works in Canada; and, in their appeal, the members of the Ontario legislature reminded the members of the Imperial Government:

> As a colony of Great Britain and as part of the British Empire, our Province is concerned in all things which contribute to the greatness and stability of the parent State, and recognizing especially how much depends upon the maintenance of her historic position as a naval power, it would be agreeable to our people that the Legislature should further in any way consistent with its obligations to the Province, and the people of the Province, the means whereby that position may be more effectively safeguarded and preserved.

This was the proposition that the Lords Commissioners of the Admiralty turned down, saying they "did not anticipate any difficulty in obtaining sufficient nickel for the requirements of Her Majesty's service through ordinary channels."

Ritchie's eloquence brought results. In 1897, and in line with Ritchie's arguments, an application was made to the Dominion government calling upon it to cancel the charter of the Canadian Copper Company. The company was charged with violating the terms of its agreement by failing to refine its own ores in Canada. The authorities were minded to grant the application, but an examination of the charter disclosed that the provision as to refining was not compulsory, as Ritchie contended, but permissive, as the directors maintained.

Ritchie then moved into direct attack. With the MacLarens, the Hastings County lumbermen who had joined the minority group in opposing the sale of the copper-nickel deposits belonging to The Anglo-American Iron Company, Ritchie formed a syndicate, called it the Canadian Consolidated Copper and Nickel Company, capitalized it at $5,000,000, and announced an intention to conduct mining operations on a large scale.

Using every political advantage he could find, Ritchie supported the passage, in 1897, of the Canadian Export Duty Act. Included in the act, which passed the Parliament, was a clause which said that when exported from Canada "an export duty should be levied not exceeding ten cents per pound on nickel, and two cents on copper." This duty applied to "nickel contained in matte, or in ore, or any crude or partially manufactured state, and upon copper contained in any matte, or ore which also contained nickel."

The provisions of the act blew up a storm that did not subside.

Ritchie used the columns of the Toronto *Globe* to attack the officers of the Canadian Copper Company; the officers of the Canadian Copper Company used the

columns of *The Canadian Mining Review* to answer in kind. Soon, in large numbers, the Canadian people were taking sides.

Each side charged the other with deceit and trickery and fraud; and when Robert M. Thompson, of the Orford Copper Company, said if a duty were placed on Canadian nickel it would compel him to import ore from New Caledonia, Ritchie described Thompson's "whole statement with regard to the competition of and the purchase of nickel ore from New Caledonia as a transparent fraud and a bunco game upon the Government."

Thompson answered:

"The Orford Copper Company has purchased in all some 8,000 tons of New Caledonia ore. . . . This means about 625 tons of fine nickel, and an equivalent of about 3,500 tons of Canadian matte. . . ."

In England, under date of December 20, 1899, Ludwig Mond wrote to Lord Strathcona, long Governor of the Hudson's Bay Company:

> It appears to be a general opinion in Canada that the Sudbury copper-nickel deposits are the only serious sources of nickel ores in existence, and that such large quantities as exist in New Caledonia — not to mention deposits known to exist in smaller quantities in Norway, Austria, Germany, Spain, etc. — are only of secondary importance.
>
> I would point out that the Société Le Nickel, which is controlled by the powerful house of Rothschilds, in Paris, has by itself produced up to the present time more nickel than has been extracted from the Sudbury ores, and that this company

is manufacturing quite half of the nickel that is produced.

Besides this powerful corporation there are other nickel mine owners supplying other European refiners who contribute at least 1,000 tons of nickel to the European market, and there appears no difficulty for any European refiner to obtain almost unlimited quantities of New Caledonia ores, in fact, I have had large quantities offered to me personally within quite recent times.

I have personally had the relative cost of refining by my process in suitable Canadian centers, such as Montreal and Quebec, carefully investigated and have found that in comparing it with the cost of refining in Swansea, in England, that there would be a very large difference of increased cost to the refiner established in Canada.

Personally, I would point out that in case the export duty was enforced against this country, it would greatly hamper, if not destroy, the whole of my scheme for smelting in Canada, and refining in England, by which I hope to enable the English nickel steel and armour plate manufacturers to be independent of foreign sources of supply for their nickel, and also to develop on a large scale the Sudbury nickel fields by driving the nickel refined from New Caledonia ores out of the market.

I would also like to point out that the English capitalist is beginning to look more and more on Canada as a country where he can safely invest his money . . . with the assurance of fair and businesslike treatment on behalf of the authorities. I know that you, personally, have taken the greatest interest and

devoted the most unremitting energy to encourage this movement, which would certainly be very much discouraged if, in one of the first attempts which is made by an English capitalist to develop industrially important mineral resources of the Dominion, his efforts were hampered by restrictive legislation of a kind absolutely unknown in the British Empire.

I think it would be of the utmost value if the Dominion Government could see its way to make some definite declaration as to what course it intends to pursue regarding this duty which at present is in suspense. You will readily see that it is practically impossible to ask either private capitalists, or the British public, to join with me in a scheme which promises to be an industrial enterprise of the very first rank and of the largest kind, when it is impossible to assure them that the undertaking may not in any way be rendered unprofitable by this export duty being imposed.

The Canadian Mining Review summed up the arguments against the Export Tax this way:

> With no process suitable for Canadian conditions, and with the American market cut off, the Canadian Copper Company cannot do otherwise than go out of the nickel business. What other option is open? It cannot use the Orford process; the Orford Company cannot work this process in Canada. Mond's process demands coal and acids at prices which Canada cannot meet. . . .
>
> The Canadian Parliament can suggest no process which is available. Will the export duty modify the

climate of Canada? Will it place coal under Ontario's forests? Will it lower the price of acids, or of chemicals, or lessen the rate of freight? Will it remove the United States tariff of $120 a ton on Canadian refined nickel? It can do none of these things. . . .

It can throw the American market open to French miners. It can force one of the largest institutions in Canada to close its doors. It can throw a thousand Canadians out of their honest employment. It can silence the noise of the drill, and put out the furnace fire. It can deter the investment of capital in a land where legislation attempts to ignore climate and geological conditions. It can do all this.

The directors of the Canadian Copper Company did send a deputation to Sir Wilfred Laurier, Prime Minister, with a threat to close its mines if the duty was imposed.

A wise administrator, Laurier must have recognized that in his campaign to wreck one company, Ritchie had put all producers in positions to be sandbagged by political forces while engaged in the continuing job of building the Canadian economy.

A wise man, Laurier must have chuckled because, on its face, the passage of the Canadian Export Duty Act was a victory for Ritchie. Only on its face. There was a catch to the legislation. The provisions of the act were not to become effective until so proclaimed by the Governor-in-Council. The proclamation was never made.

8

Nickel Changed All This

ON April 24, 1898, Spain declared war on the United States. On December 10, 1898, the war was over. Between the two dates were two events that changed the weapons of the world. The events were the Battle of Manila Bay and the Battle of Santiago de Cuba. In these two battles, the American warships clad in nickel steel armor destroyed almost the entire Spanish fleet without the loss of a single vessel. The American casualties were one dead and seven wounded. Immediately, there was a quickened economic and political interest in nickel.

Up to the time of the Spanish-American war the three mines — Copper Cliff, Stobie and Evans — of the Canadian Copper Company supplied much of the Sudbury ore. With the war over, other producers began to appear. Ritchie's Canadian Consolidated Copper and Nickel Company was already organized (it never got much farther than the talking stage); and, in Hamilton, John Patterson, a businessman, promoted the formation of two nickel companies. The companies were the Hoepfner Refining Company, Limited, and The Nickel Copper Company of Ontario, Limited.

Patterson became interested in nickel following an inquiry from English steel manufacturers as to the feasibility of making nickel steel plates in Canada. Satisfied the idea was practicable, Patterson looked around for a way to refine nickel, heard about the Hoepfner process which had been found unsatisfactory by the Canadian Copper Company, became convinced changes had bettered it, talked over the proposition with fellow businessmen in Hamilton and, on July 24, 1899, incorporated the Hoepfner Refining Company, with a capitalization of $600,000.

There were 6,000 shares of stock, valued at $100 a share. Of the total number 5,500 shares were issued, and a thirty-year contract was signed with Hoepfner for the use of his electrolytic process. A refinery was built in Hamilton.

Before going very far realization came to Patterson and his associates that to compete in the United States market changes would have to be made in the tariff regulations. They found an ally in Ritchie and, through him, succeeded in persuading Archibald Blue, Director of the Ontario Bureau of Mines, to write a memorandum to the provincial government containing these recommendations:

1. The reopening of negotiations with the British government for the purpose of inducing it to take an active part in the refining of nickel in Canada.

2. An appeal to the Dominion government to enforce the duties authorized by Parliament on exports of nickel-copper matte; and

3. The inclusion of a provision on all future grants of land that nickel and copper found in them must be refined in the province, the penalty for failure to comply to be forfeiture of the grant.

The three recommendations were approved by the Ontario government with the passage on November 24, 1899, of an Order-in-Council.

Anticipating great good fortune, Patterson then organized and incorporated The Nickel Copper Company of Ontario, Limited, on January 9, 1900. This was a company that was set up to mine ore and supply matte to the refinery. The capitalization was $5,000,000, more than half of which was subscribed.

In 1900, the company made its first investment in the Sudbury district, buying the Whistle deposit from Rinaldo McConnell. Three years before, Isaac Whistle and Arthur Belfeuille had been prospecting along the northern rim of the nickel range when they spotted a gossan-covered hillside. Accepting it as evidence of an ore deposit, they named it the Whistle mine and had sold it to McConnell.

Quite a bit of testing and development work was done on the property by The Nickel Copper Company, Limited. Some ore was taken from the mine, but commercial operations were never carried on — at the mine or at the refinery.

There was trouble in Hamilton. Hoepfner's electrolytic process was not doing well and when Hoepfner died suddenly in Colorado the company turned to a formula worked out by Hans A. Frasch, resident manager of the refinery. Frasch's process also failed.

Undismayed, Patterson and his group formed a third company, called it the Nickel Steel Company of Canada, and proceeded to buy nickel and iron properties in Ontario, coal lands in Pennsylvania, and manganese deposits in Nevada.

The great good fortune did not come.

Unfortunately for Patterson and his group, the recommendations approved by the provincial government ended with the same authorities. Apparently, they were recommendations that were never forwarded to the Dominion government, or through the Dominion government to the British Parliament.

On the other hand, the provincial government did change the form of land contract, and bound "future grantees of nickel-copper lands to refine the ores in the Dominion of Canada." For a time all grants of mineral lands were subject to this condition. In 1900, in the Act to Amend the Mines Act, 63 Victoria, chapter 13, section 3, the situation was clarified "and the requirement annulled as regards all grants already made."

In the Report of the Royal Ontario Nickel Commission (1917) this action by the Ontario government was characterized as "the first attempt by the Legislature to set up machinery which would operate to provide revenue, and at the same time exercise pressure on mining companies to refine their nickel and copper ores in the Province. . . ."

Continuing the report, the commission recalled:

> Some of the nickel mining companies petitioned the government of Canada to disallow this Act, partly

> on the ground that it interfered with the right of that government to regulate matters of trade and commerce, and partly because, as they alleged, its provisions practically amounted to confiscation of their properties.
>
> The Minister of Justice, Hon. David Mills, impressed by these representations, communicated his objections to the government of Ontario. The Attorney-General for the Province, Hon. J. M. Gibson, defended the legislation, and it was eventually agreed (May 1901) between the two governments, that the constitutionality of the Act should be referred to the Supreme Court.
>
> No reference was ever made. Owing to the Act not having been proclaimed by the Lieutenant Governor-in-Council it remained a dead letter, and was repealed by the Mines Act, 1906.

Yet, even before it intruded into Patterson's hopes, failure was nodding in the direction of another promoter, by name Francis Hector Clergue. Out of Boston, and backed by Boston dollars (more than $100,000,000, so it was said), Clergue visioned the Canadian Sault Ste. Marie as the sure emplacement for steel plants, paper mills, nickel refineries, copper refineries, carbide plants, chemical plants, ironworks — a dozen industries.

"And why not?" ran his enthusiasm. "On the doorstep of the 'Soo' flows power in inexhaustible quantities from the rapids of the St. Mary's river; in the Soo backyard are gold and silver, copper, lead, iron, timber — the wealth of a nation waiting the coming of men possessing and possessed by the driving desire for opportunity."

The whole scheme began as a power development.

Early in its history, Sault Ste. Marie started developing the water power formed by the rushing plunge of St. Mary's river from Lake Superior into Lake Huron. It was not long before the undertaking was beyond the financial means of the community, so that when Clergue came along in 1894 he was able to take over the power rights and a partially built power plant on his own terms. The power plant was completed, and the development came to be called the Consolidated Lake Superior Company.

It was the intention of the company to sell the power. Customers were scarce. Clergue then decided to develop his own markets in the form of manufacturing industries. Having been given large, very large, grants of timber lands by the Ontario government, the first use of the power was in a mechanical pulp mill. To make sulfite pulp, for which there was a growing demand, Clergue needed sulfurous acid.

The most convenient source for the acid was the sulfide ores of Sudbury. Clergue approached the Canadian Copper Company. Failing to agree on terms, Clergue decided to make his own acid, and bought the Gertrude deposit.

Having copper and nickel and sulfurous acid, the Boston promoter's speculations expanded to include iron. His agents streamed into the wilderness north and to the west of Sault Ste. Marie. In the Michipicoten district, near Lake Wawa, there was iron in commercial quantities, diamond drilling indicating deposits of as much as 5,000,000 tons. Getting in touch with the Krupps, Clergue made contracts for the delivery of large quantities of ferronickel. At least, he so reported to the Canadian press.

Soon, in Sault Ste. Marie were blast furnaces, a steel

plant, a charcoal plant, a brick plant, chemical plants, pulp mills — and, to link the plants with the mines, the forests and the market, Clergue bought steamships, ore docks, and constructed two railway lines. The two lines were the Algoma Central and Hudson Bay Railway, and the Manitoulin and North Shore Railway.

The right of way of the latter railroad was carefully conceived. The first section was thirteen miles long. It connected the Gertrude deposit with Sudbury, and passed close by five other deposits, including the properties of the Canadian Copper Company. When completed, it was designed to traverse the main nickel range, almost from end to end. The Algoma Central and Hudson Bay Railway tapped the iron mines, and was planned to operate as far as Hudson Bay.

All this activity attracted a great deal of attention, and Clergue added to the excitement by announcing that the principal output of his steel mill would be nickel steel rails.

"By a new process," the announcement said, in effect, "we will be able to reduce the cost of nickel steel so as to make it available to all railroad companies. Railroad people know, although the public may not know, that nickel steel will surpass, in wearing qualities, the ordinary steel rail as much, if not more, than the steel rail surpassed the iron one. We expect to produce nickel steel for about $30 a ton. The demand for such rails is expected to be enormous."

Commenting upon the sensational announcement, *The Canadian Mining Review* (January, 1900) advised its readers to regard the statement with caution, and reconnoitered Clergue's claim by editorializing: "The apparent impossibility of the achievement will be seen when it is remembered that the nickel steel armour plate for the new United States battleships is costing about $400 a ton."

Possessed by the vision of a kingdom, Clergue did not back up. It was a kingdom in which the restlessness of a river supplied the power that turned forests into pulp; of mines that in the conversion of their ores supplied an acid that converted the pulp into paper, and in the process left behind metals of great value; of the refinement of those metals into a completeness that left nothing for the slag pile but shattered and worthless rock; of steamships and railroads, of factories and homes, churches, schools, stores and docks — a great city on the shores of the channel that joined the waters of Superior and Huron.

Clergue was aware that the ore from the Gertrude deposit was generally accepted as being particularly suitable for ferronickel because of its high nickel content (as high as 6 per cent) and its low copper content (as low as 1 per cent). In Clergue's employ was E. A. Sjostedt, a metallurgist who was confident he had a process that would separate the small percentage of copper, and thereby rub out the objections of steel manufacturers who regarded the presence of copper as "certain to render any kind of steel useless."

Sjostedt's experiments not only indicated complete separation of copper and nickel but, according to Clergue, established a way to save the nickel, the copper, the sulfur, the iron and whatever other metals there were in the ore. In 1901, the company added the Elsie deposit, planning to reduce the ores to matte at a three-furnace smelter under construction near the Gertrude deposit.

Another year was scarcely over when nickel was living up to its reputation of being, as Paul D. Merica said of it many years afterward, "a metal of adversity."

As the ore bodies, including the Gertrude deposit, were opened, the nickel content did not increase but the copper content did; and the increased copper content multiplied the difficulties. Excepting at prohibitive cost, Sjostedt saw no way to do what he had hoped to do.

Quickly, idleness replaced the urgency that had permeated the towers and battlements and portals of the massive stone buildings that housed the activities of the Consolidated Lake Superior Power Company. Clergue had spent a reported $30,000,000.

In 1903, the bondholders moved in; relief came when the Ontario government guaranteed, for a period of years, the bonds of the iron and steel plants. The other companies disappeared.

The names of Clergue and Patterson were postscripts to the list of failures. It was a list already long. Unless investors remained close to shore, failure was almost inevitable. In fact, sticking close to shore was no assurance of safety.

The market for nickel was limited. Technical skills were lacking. In Canada there was no economical method of refining. In Europe, there was a great deal of prejudice against Canadian nickel, particularly among armor plate manufacturers. They refused to use it. As for nickel steel, there was much opposition to it in machine shops generally. It was hard to handle with the machine tools in use; and there was reluctance to spend money on new tools.

The Sudbury mines were erratic and equally erratic was the demand for nickel. The demand might remain fairly steady for a few years, three or four; then would fall off suddenly. As a result, newly erected facilities, or newly opened deposits, would be shut down. Robert M. Thompson wrote of commercial conditions in this period:

> The metallurgy of nickel remains a difficult problem. . . . So far America has held its own in the race, and the nickel from the Canadian deposits at Sudbury, refined by the Orford Copper Co., holds . . . fully one-half the market of the world. All sorts of solutions of the nickel problem are being presented. . . . The large makers of steel are now satisfied that they can secure ample supplies at a reasonable and steady price.
>
> Still, the very large expenditure necessary for plant for any of the proposed processes, and the very great skill required, make capital timid about entering into a field where the competition must be keen and the losses for all engaged in it great.

Stormy winds to the contrary, there was progress. In Sudbury, there was a newspaper paragraph to this effect:

> Thomas Edison, of Orange, New Jersey, and Mrs. Edison; his brother-in-law, J. W. Miller, and C. M. Chapman, of the same place; also Luther Stierneger, an electrical engineer from New York, rented Mr. Scully's building on Larch Street to be used as an office while exploring the district for nickel.*

Needing the metal for his newly invented storage battery, Edison spent quite a bit of time and quite a lot of money diamond-drilling in the area, but found no ore

*THE FIRST SEVENTY-FIVE YEARS — *A Headline History of Sudbury, Canada* by Charles Dorian. Arthur H. Stockwell Ltd., Ilfracombe, Devon, 1959.

deposits. His drillers quit too soon. The ore was present in quantity. They did not drill deep enough.

The battery was shown at a meeting of the American Institute of Electrical Engineers in New York on May 31, 1901. In explaining the battery, an Edison representative said:

"The negative pole, or positive element, corresponding to the zinc of a primary cell, or the spongy lead of a secondary cell, is iron. The positive pole, or negative element, corresponding to the carbon of a primary cell, or lead peroxide of a secondary cell, is a superoxide of nickel believed to have a formula NiO_2. The cell is therefore a nickel-iron cell, a name which suggests the structural material — nickel steel."

In 1901, the New York Electric Vehicle Transportation Company had 100 of the batteries in service. They averaged 1,000 miles a month. In the large electric broughams and hansoms which were in common use on the streets, the total mileage on one charge was from forty-five to fifty miles. Today sedate electric broughams and electric hansom cabs have given way to traffic policemen and DON'T WALK signs. The Edison storage battery continues to serve, with nickel hydrate continuing to be the best material for the positive electrode.

While Edison was still experimenting with his storage battery, nickel made its appearance in a nickel steel axle installed in a gasoline-propelled car built by the Haynes-Apperson Automobile Company of Kokomo, Indiana. In 1899, the car traveled from Kokomo to New York, a distance of about 900 miles, without serious trouble. The axle was made by the Bethlehem Steel Company.

Reporting on the use of nickel in automobile axles, Elwood Haynes addressed a meeting of the American

Society of Mechanical Engineers at Indianapolis, Indiana, in May 1907, and said:

> So far as is now known, this was the first material of this kind ever used in an automobile. Nickel steel was used in the axles of cars of this construction for about five years, and not a single case of breakage occurred during that period. Not only was this steel found to be practically free from crystallization, but it possessed a very high elastic limit. . . .
>
> Soon afterward nickel steel was introduced into the construction of driving chains, and those chains showed great superiority over the ones formerly made of ordinary steel. When the sliding gears were first used on the automobile for the purpose of changing the gear ratio between the motor and rear axle, trouble was again encountered in breakage.
>
> Gears were made of the best kinds of tool steel without success. The ends of the teeth would break off when an attempt was made to throw them suddenly into engagement by means of the shifting levers. Trouble of a very serious nature resulted from this, as pieces of the broken teeth would get into the other gears, thus causing them to break, and sometimes the entire train of gears would be almost ground to pieces on account of the breakage first of one gear and then of another. . . .
>
> It was finally discovered that an alloy consisting of iron, nickel and chromium possessed most remarkable properties. Not only could the steel be hardened by heating to redness and quenching in oil, but it could be given a considerable amount of toughness

> at the same time by drawing the temper somewhat after the first hardening.
>
> If the steel was properly made and afterwards properly treated, it was found to be almost impossible to break one of the teeth in a 6-pitch gear by means of a heavy hammer. So successful were these gears that they rendered it possible to run an entire season sometimes without the breakage or serious injury of a single tooth. Front axles, steering knuckles, and other important parts requiring high elasticity were made of this steel in certain cars with very good results. . . .

Acceptance of nickel by the automobile industry came slowly, but when it came it had a far greater impact on a nation's economy, and on the economy of the world, than any armament race between any group of nations, or between all nations, at any time in the history of the world.

For, as Haynes also recalled in Indianapolis in May 1907:

> Since the first attempt to build automobiles, early in the 90's, experimenters have had difficulty in getting materials suitable for the purpose. Steel of high tensile strength was employed but the results were not satisfactory. Lower carbon steels were tried, but they lasted only a few weeks, or months, and then broke off short.
>
> Swedish iron did not break, but when the first hard bump was encountered it took a set and the wabbling rear wheels indicated what had happened. Finally a steel of moderately low carbon was intro-

duced which gave only fair results, and if the car was driven for any length of time over rough roads, this also crystallized and broke off.

Nickel changed all this.

Since January 1899, when Ludwig Mond agreed to pay $200,000 for the Victoria mine, his investment had increased to more than $300,000. On September 20, 1900, he formed The Mond Nickel Company, Limited, and on October 16, 1900, the company obtained a license to operate in Canada. To see for himself what was going on in his properties, Mond went to Sudbury in the latter part of October 1900.

In *The Life of Ludwig Mond,* J. M. Cohen recalled the trip on which, with his son Robert and the mining engineer Dr. Mohr, Mond spent six weeks traveling in a private car furnished by the Canadian Pacific Railway. The car was his home.

One day, as the car was shunted to a stop near the Victoria mine, Ludwig opened a door and shouted for a porter. None appeared. He shouted again. Again. Hiram Hixon, the mine manager, rushed up and explained to the exasperated Mond that porters were not available in the north country. Shouldering Mond's big trunk, Hixon carried it to a small frame house nearby. It was where the mine manager lived. There were no sidewalks, and no pavement. Within a hundred yards were trees to the bark of which hung patches of hair where bears had rubbed.

In Sudbury, after a cold, hard day of buggy-riding inspecting outcrops, Mond, his son and Mohr, led by Hixon, shoved their way through the drillers and muckers crowded into the hotel barroom. Taking seats at a table

off in a corner of the room, they were waiting to be served when a voice bellowed: "Take off your hat!"

Quickly, Ludwig removed his large, black hat and bowed an apology to a scowling bartender. Just as quickly, in challenge, Hixon put on his hat. His scowl deepening, the bartender took a step forward, then stopped, the scowl changing to a smile of welcome. Suddenly he had recognized his visitors.

This was Rinaldo McConnell's country, and his people. Whatever meetings McConnell may have had with Mond were in a railroad car, in a clearing, or in a saloon. It was quite a change from the first meeting of the two men in the Palazzo Zuccari, and its balconies from which could be seen the streets of Rome and the dome of St. Peter's.

Prior to Mond's visit by about six months, Hixon, a metallurgical engineer, was sent to the district to superintend the building of a smelter while, in Clydach near Swansea, Wales, on February 12, 1900, Mond had begun the erection of a refinery. It was Mond's plan to roast, smelt and Bessemerize the ores in Sudbury, and ship the matte to Clydach where he would use his carbonyl process to recover the nickel.

Earlier still, Major R. G. Leckie, who was Thompson's personal representative in Sudbury, had brought suit against McConnell for selling the Victoria mine, it being Leckie's contention that McConnell lacked a clear title. Leckie lost, but while his case was awaiting court decision (1899) Mond was in an uncertain position.

There were long-drawn-out and caustic-tongued negotiations with the Canadian Pacific Railway and the provincial government before any real work could get under way toward the development of the mine; and while negotiations were inching ahead, Gulbrand Henriksen, a mining engineer, was using a compass needle to measure and to map out ore deposits in nearby terrain.

Henriksen's calculations as to the amount of ore in the Victoria mine, and the presence of ore nearby, were not acceptable to Mond. Intending to issue a prospectus upon the formation of a public company, Mond employed an outside consultant to survey the Victoria development. The report which was made in the summer of 1900 was discouraging. The consultant did not believe that development of the property was at a point justifying the issuance of a favorable report.

Meanwhile, Hixon had become persuaded that mining properties other than the Victoria and Garson deposits (the latter was acquired by Mond not long after the purchase of the Victoria mine) were needed. Mond did not agree, nor did he disagree. He authorized Hixon to take an option on the Levack mine. Located about sixteen miles north of the Victoria mine, it was the first deposit located on the northern range.

A second mining expert was sent to survey the different properties. He, too, made a discouraging report, giving it as his opinion that the Victoria mine would not produce more than 100,000 tons of ore, and expressing doubt that Mond had ore in sufficient amount to warrant the launching of a publicly owned company. Mond bought the Little Stobie mine in Blezard township, and took an option on the Sheppard deposit close by. With these properties added to what he had, Mond was satisfied his company was on sound footing.

On May 17, 1901, a subscription list was opened for the purchase of stock in The Mond Nickel Company, Limited. The announced capital was approximately

$2,800,000. For the business, the patents (seventy in all) and the properties, Mond received a little more than $1,500,000. In the development work, he had spent more than $1,250,000 from his own pocket.

The company was pretty much a family affair. Ludwig Mond was chairman; his sons, Alfred and Robert, were directors; so, too, was Carl Langer; Robert Mathias, a nephew, was appointed secretary. For Ludwig Mond, and for the others, but particularly for Ludwig Mond, the company was the reward for more than ten years of rejecting all counsel that tended to hinder what was being built.

But before the subscription books were opened, the Victoria mine was in operation, and in the latter part of the 1901 summer the smelter was turning out copper-nickel matte for shipment to a refinery not yet completed in Clydach.

In 1902 the Clydach plant was shut down for eight months. In the summer, there was a long labor dispute; also there were a number of serious accidents due to technical difficulties in the refining process. Losses were heavy. Mond reached into his own purse for the money, in addition to paying accrued dividends of more than $65,000 to the preference shareholders.

In 1900 the Creighton mine was brought into production by Canadian Copper. This was the deposit suspected by Surveyor A. P. Salter, and confirmed by Geologist Alexander Murray in 1856. The finding was officially reported to the Canadian government. No one seemed to be interested. The discovery became an incident; and soon the incident was forgotten, along with the official records which, by this time, were entirely and utterly buried among the back papers in the archives of a nation's history.

Thirty years were to pass before Henry Ranger, a prospector in the employ of Rinaldo McConnell, was snooping along the ridges and through the marshes west of Sudbury when he came upon a long gossan-stained area. In the autumn of 1886, he made application for title to the property, and learned that more than a year previously (July 10, 1885) J. H. Metcalf and W. B. McAllister had filed a similar application, although they failed to make any mention of a deposit.

In 1885, Metcalf and McAllister sold their pending application to Samuel J. Ritchie. On January 24, 1887, a patent was issued to the Canadian Copper Company, but not until Ritchie had established the location of the property by sending J. W. Evans and Thomas Baycroft to the site. They verified it. Not only did they do that, but they found the post which marked the junction point of the four townships of Creighton, Snider, Waters and Graham. The deposit was a handshake away. It remained untouched for another ten years, and more.

9

International Nickel Is Formed

IN an era when oil and steel were expanding into great industries, it was natural for Robert M. Thompson to have dreams about nickel. Thompson was a man who thought in capital letters.

Regularly, each year, he went to Europe to hobnob with the Rothschilds in France, with the Kaiser in Germany, with Edward, Prince of Wales, in England, and with businessmen in the three countries. These were the business trips from which he never returned without a pouch filled with orders. Every few years he gathered together a congenial group, chartered a steamship and made a trip around the world, paying expenses by picking up and discharging cargo at different points.

He never missed an Army-Navy football game. Engaging a special train, he filled it with guests including

— more often than not — the Commandant of the Military Academy at West Point, decorated the train with Navy colors, and jeweled it with hundreds of chrysanthemums.

Going to the game, luncheon was served; returning to New York after the game, dinner was served — at the game, Thompson, with top hat and cane, always led the Navy team onto the field.

In the less than twenty years since the dissolution in July 1887 of his partnership with W. E. C. Eustis in The Orford Copper and Sulphur Company, his assumption of a debt of $450,000 and the taking over of the smelter at Constable Hook, Thompson had won a position equal to the Rothschilds in the nickel markets of the world. The Canadian Copper Company supplied him with matte; in Copper Cliff, in 1900, he had built a smelter to add to his flourishing business in Constable Hook.

In the office of the Orford Copper Company at 99 John Street were ten people. Thompson was president; Miss Carrie Van Brunt was secretary; Isaac W. Clarke was treasurer. There were six clerks and one office boy. Around the nearest corner was Broadway, and down Broadway a few blocks, five or six, was 26 Broadway. This was the address of the Standard Oil Company, and the Rockefellers.

If he was to do what he hoped to do, Thompson had to have money. Lots of money. He made a telephone call, listened attentively, put the receiver back on the hook, left his office and went to 26 Broadway.

For a while Charles Lawler, his office boy, was kept busy running between the two offices in response to Thompson's urgent calls for additional files. After studying the information turned over by Thompson,

H. H. Rogers, trusted associate of the Rockefellers, turned down the proposition. With the Rockefellers, he did not agree with Thompson's enthusiasm for nickel, nor with his optimism as to its future.

Disappointed but not discouraged, Thompson shortened his sights, moving up Broadway from Number 26 to Number 71. At 71 Broadway were the offices of the newly organized United States Steel Corporation. Lawler continued to run back and forth with the files.

The interest of certain executives in the steel corporation was immediate, and genuine.

They knew that nickel steel was coming into use in automobiles, and in seamless-drawn tubes. They knew that engineers were planning its use in bridges. They were young, and successful, and willing to risk. The fact that Thompson's proposal included the purchase of the Canadian Copper Company, with its supply of Sudbury ores, of known richness but as yet undetermined extent, was an important factor.

It was the foundation on which the company was built. Thompson believed, and so did former Carnegie steel men, Schwab, Monell and Wood, that there was ore in quantity in the Sudbury area, and that it could be found. The fact that New Caledonia was supplying 65 per cent of the market was a detail.

Thompson himself was responsible, in part, for the position of New Caledonia ores. He was a buyer, and a smelter, of the ores. Moreover, the Canadian Copper Company, while controlling its Sudbury ores, also was dependent upon Thompson for the refining of its ores.

In the negotiations with Schwab, Monell, and the others, Thompson promised he could deliver all or most of the shares of seven companies for the new enterprise.

For the most part, the companies he named were members of what he considered his own family.

He could deliver the stock of the Orford Copper Company which he owned, and also of the American Nickel Works, a small plant owned by Joseph Wharton engaged principally at this time in the production of metals and salts from materials supplied by the Orford Copper Company.

He was sure he could bring in the Canadian Copper Company and the closely affiliated companies, The Anglo-American Iron Company and the Vermillion Mining Company. Thomas W. Cornell and United States Senator H. B. Payne, two of the original stockholders in the Canadian Copper Company, were dead. Their heirs were willing to get out of the nickel business. Stevenson Burke, third of the original backers of Ritchie, was working with Thompson in pulling together the loose ends.

Further, in 1899, Thompson had gained control of the Nickel Corporation, Limited, in England and in 1900, in New Caledonia, a company known as Société Minière Caledonienne. Each company controlled acreage in New Caledonia.

Naturally Thompson put his best foot forward in the negotiations. Actually the new enterprise was not nearly so all inclusive as it appeared to be. Only two of the companies had real standing. None of the other companies had any significant income either before or afterwards. The two companies of standing were the Canadian Copper Company and the Orford Copper Company, the former owning substantial nickel-copper ore deposits in the Sudbury District but not having evolved a satisfactory method of refining the products in its ores, and the latter

having developed an efficient method of refining such products but having no ore deposits. It was natural that the two should be joined. Together they had annual net earnings of about one million dollars.

Toward the end of March 1902, Thompson reported the completion of his part of the agreement. By letter, he told Schwab, Monell and the others that he controlled the disposition of the agreed number of shares of the stock of the seven companies included in the discussions, and offered to turn them over, together with a certain amount of working capital, to the new company in exchange for securities thereof.

Acting for the International Nickel Company, Howard K. Wood, temporary president, notified Thompson of the receipt of his letter, and the acceptance of his offer. On March 29, 1902, the International Nickel Company was incorporated under the laws of the State of New Jersey.

Authorized was a capital of $24,000,000. In addition, the company was authorized to issue $12,000,000 in 5 per cent First Mortgage Bonds. Issued were First Mortgage Bonds: $9,890,836.51; 6 per cent Preferred Stock: $8,912,626.09; Common Stock: $8,912,626.09 – a total of $27,716,088.69.

Officers were: Robert M. Thompson, Chairman; Ambrose Monell, President; E. F. Wood, First Vice President; J. R. DeLamar, Second Vice President; S. H. P. Pell, Secretary; James L. Ashley, Treasurer. Directors were: Millard Hunsiker, S. H. P. Pell, A. W. Maconochie, A. H. Wiggin, Robert M. Thompson, Ambrose Monell, E. F. Wood, E. C. Converse, Max

Pam, Charles M. Schwab, Joseph Wharton and Leslie D. Ward.

It was a young management. E. F. Wood, First Vice President, was the eldest. He was forty-three years old. Ambrose Monell, President, was the youngest. He was twenty-nine years old; but he was not Charles M. Schwab's first choice for the job.

While details of organization were being worked out, Schwab went to London, and invited Henry Gardner to call on him at the Carlton. Gardner responded, and heard a friendly voice: "Mr. Gardner, I am here to offer you the presidency of the International Nickel Company."

Being a friend of Thompson, and knowing of the negotiations, Gardner voiced his thanks, but shook his head.

Schwab was persistent, finally saying, half-jokingly: "You should feel honored, Mr. Gardner. I am seeing only two people today, the King and yourself."

Gardner expressed his appreciation of the compliment, explained he did not wish to leave a firm "to which I owe everything," and suggested: "What you really need, Mr. Schwab, is a man who will treat the matter as a large-scale production job. Why don't you put one of your bright young steel men on to it?"

The two men talked at length until, convinced Gardner would not change his mind, Schwab left to keep his appointment with the King.

Henry Gardner, the man Schwab tried so hard to get, came to have a great deal of influence on the affairs of the International Nickel Company. He was born in Glasgow in 1859. When he was eighteen years old he became a junior clerk in the office of Henry R. Merton & Co., London metal brokers.

Office hours were from nine o'clock to six o'clock. When reporting for work on his second day, Gardner was called on the carpet and asked to explain why he got up from his desk and left promptly at six o'clock on his first day. He invited the attention of his superiors to the published hours of work, as told to him when he was hired. He was informed he "could leave at six, but only if all the work in the office has been finished."

At the end of the year his salary was raised from about $4.50 a week to about $5.50 a week. He went in to thank his employers, and learned a mistake had been made. After a period of self-recrimination and job-examination, the partners permitted the pay increase to stand.

During the year Gardner's duties had been increased to include taking dictation and writing out in longhand letters for the signature of S. R. Zunz, assistant to Henry R. Merton. On his own, but with the encouragement of Zunz, Gardner had taken up the study of shorthand.

With no Saturday afternoons off, he used his evenings not only for the study of shorthand, but to dip into languages such as French, Spanish and German, and to probe into the chemistry of metals. It was not long before Henry R. Merton & Co. discovered that where once it could do without him, he now was necessary to it. When Schwab came to see him, he was a partner in the firm. Until his death in 1941, he was the wise and trusted adviser and friend of the successive heads of International Nickel, particularly in the shaping of European commercial policies.

At the same time Gardner was getting ahead at Merton's, Ambrose Monell was doing the same thing at the Carnegie Steel Company. At the Carnegie Steel Company he was chief metallurgical engineer and assistant to the president, having gone to work for the company following his graduation from Columbia University.

At the university, Monell and George Whitfield were friends. Good friends. Such good friends that when Whitfield was invited to visit his sister and brother-in-law in Scotland, he was able to have Monell included in the invitation. The brother-in-law was Andrew Carnegie. In Scotland they went fishing with Carnegie. Monell had a good time. He caught more fish than anyone. Pleasantly, but in a brash, college-boy way, he offered to show his host how it was done.

The following morning the college boy and the steel manufacturer were together again, fishing. The older man listened to the youth's instructions, followed them as well as he could, and caught fish.

What he did not know, nor did Monell tell him, was that his young coach had been brought up with a rod in one hand, and a gun in the other.* But Monell did talk about some things. In response to questions, he told Carnegie of his studies, that he was planning to become an electrical engineer and, after graduation from the

*George M. L. LaBranche's fishing classic (*The Dry Fly and Fast Water* and *The Salmon and the Dry Fly*, Copyright, Charles Scribner's Sons, New York and London) credits Monell with being probably "the first angler in this country to take a salmon on a dry fly"; and says of him, "a better sportsman I have never known. As a salmon angler he was unequalled."

The one book, *The Salmon and the Dry Fly*, was written as a tribute to Monell. In the *Preface*, La Branche disclosed that Monell had agreed "to collaborate with me. Unfortunately, he never saw but part of what is now the first chapter. . . . The war took him abroad and, while the work had been started before he left, it was put aside for more important things. . . .

"Those who may pick up the book to read . . . are asked to remember that it is intended as a memorial to a man who was a great angler, and if his name is preserved to future generations of sportsmen because of it, I shall be content."

Columbia School of Mines, he hoped to find congenial work in the study of metals.

"When you graduate, come and see me," said Carnegie. "I'll see if I can find something for you to do."

Monell was in Carnegie's employ only a few years when he redesigned the ports on the open-hearth furnaces. The change brought substantial savings in the cost of fuel. To Monell, it brought a bonus check for $25,000 and a commendation from Carnegie. His rise in the company was so notable that when Schwab reported Henry Gardner's refusal, Monell was selected from a group of Carnegie's "bright young men."

Schwab had no objections. At twenty-five Schwab was superintendent of Carnegie's Homestead Works in Homestead, Pennsylvania; at thirty-five, he was president of the Carnegie Steel Company; before he was forty years old, he was president of the United States Steel Corporation. He received Carnegie's suggestion with open pleasure.

Announcement of the formation of the company did not come as news. For weeks prior to the filing of the incorporation papers, rumors were sweeping over Ontario that the Sudbury mines had been sold, or were about to be sold, and it was the intention of the new owners to close the mines in favor of New Caledonia operations.

In the Toronto *Globe* (March 21, 1902) Thomas W. Gibson, Director of the Ontario Bureau of Mines, was quoted to the effect that "while I have no official information, I have heard that Charles M. Schwab, and others, have purchased a controlling interest in the Sudbury mines. I have no fear that they will be closed down, as the product is needed."

And he supported this assurance by saying: "The only other sources of supply for the world's wants are the mines of New Caledonia, which cannot successfully compete with ours, on account of their great distance away, the fact that they are worked by convict labor, and other disadvantageous conditions."

Rumors persisted, and became so clamorous that on April 4, two days after the newspapers carried press dispatches telling of the formation of the company, Gibson again assured readers of the Toronto *Globe,* "The [Sudbury] deposits are too valuable, and the metal in too active demand, to warrant anything like a stoppage in production. It is a mere change between American companies, and so far as I can see does not call for any action on the part of the Bureau of Mines."

The Ontario Premier and his Ministers chose this time for a tour of the mining and lumbering sections of northern Ontario. They found in Sudbury, "a brisk town of 2,500, the result of the active mining operations of the nickel-copper belt, and the presence of 5,000 lumbermen in the woods within a radius of 30 miles. Adjoining Sudbury," continued the report, "is Copper Cliff, the scene of the Canadian Copper Company's operations.

"This company has doubled the number of its employees in the last couple of years . . . but owing to the recent change in ownership by which the property was taken over by the International Nickel Company, several hundred men have been temporarily laid off until the new conditions are adjusted" — and, perhaps with the ears of the new owners in mind, the Premier chose Sudbury as a place to announce that "the south end of the railway between Sudbury and Parry Sound will be

under contract in May [and] the construction of the Manitoulin & North Shore Railway southward to the heart of western Ontario."

The reaction in the Dominion Parliament was mixed. In the proceedings of April 18, critics raised the question as to "whether Canada was advancing its own best interests by permitting the export of nickel in the lowest forms and submitting to the American tariff"; repeated the plea that "all nickel mined in Canada be refined in Canada"; and urged England to study a situation that "might have an influence on the supply of nickel for armor plates."

The critics were reminded that "several years ago the Government took power to levy export duties on nickel, but after full consideration of the question it was not deemed to be in the best interests of the country that a duty at the time should be imposed." After a few more nips at the subject, the critics joined in consideration of other things.

Closing the Sudbury mines was a move that never was considered. Actually, the new management was thinking in terms of expansion for its Canadian operations. Although young, the new management was not frivolous. There was no novelty to its problems. More than anything else, it needed to widen the markets for its products. To do this it had to find new uses, and better ways of production.

In the summer of 1900, Thompson had built the Ontario Smelting Works at Copper Cliff. The purpose was to bring up the metallic contents of the low-grade matte by re-treating it after it came from the furnaces of the Canadian Copper Company. The results were good.

How good was shown in the 1901 Report of the Mines Department of the Ontario Government:

> The average value at which the nickel contents of matte were appraised in 1900 was 10.7 cents per pound while, in 1901, it was 20.9 cents. Only about one-half the product of the Canadian Copper Company's smelters was treated at the Ontario Smelting Works last year, consequently, the total increase in value of the nickel is not so great as it would have been had the whole of the product been re-handled.

The new treatment which, largely, was worked out by Victor Hybinette was a distinct advance. It raised the metallic contents of the matte from 30 per cent to 70 per cent. This was brought about by crushing, grinding, calcining and resmelting the matte, thereby ridding it of a great deal of iron and sulfur. Left was a substance much closer to the point of separation of the metals, and actual refinement.

In the ten years beginning with 1892 and ending with 1901, the nickel and copper mines of Ontario produced 1,307,000 tons of ore. Of this total, 1,245,000 tons were smelted into matte containing 26,600 tons of metallic nickel and 28,100 tons of metallic copper. As a refined metal, the nickel was worth $20,500,000, and the copper $7,000,000. In 1892, the mines employed 690 men and paid out in wages $340,000; in 1901, the mines employed 2,284 and paid out in wages $1,046,000.

The Canadian Copper Company was working six deposits and operating thirteen Herreshof furnaces of 125 tons capacity each in Sudbury. The monthly production of matte was about 2,400 tons. Almond Penfield

Turner was president of the Copper company, and the new management gave him a lot of things to do.

There was need for a resident doctor in Copper Cliff. Theobald Coleman, a Toronto physician, was brought in and given a three-year contract. A hospital was built. Nurses were employed. The Bank of Toronto opened a branch, with John R. Lamb as its manager. Later, Lamb became Chairman of the Board of Directors of the bank, and a director of The International Nickel Company of Canada, Limited. The community was without electric lights, and without a waterworks. It did have a newspaper.

Joe Pratt came from Owen Sound to start one. He called it the Copper Cliff *Courier*. As a vehicle of news, the *Courier* lacked a great deal, but as a vehicle of untrammeled speech it made a substantial contribution to the life and times of Copper Cliff. Looked for were the items in Joe's column, and the advertisements of the local merchants; and they were looked for well beyond Copper Cliff — by newspaper paragraphers in Toronto, Montreal and New York.

Items such as:

Joe's enthusiasm for things for which Copper Cliff was famous, among them, as he described it, "a lacrosse team equal to none"; or, the large display advertisement that declared: "Bob Waite still has to show them all how to run a livery business, and to offer good looking horses to trade for poor ones."

Joe Pratt was not Copper Cliff's only biographer. Kathleen Blake Coleman, wife of the town's medical officer, was a regular contributor to the Toronto *Mail and Empire* where she wrote and edited a Saturday page entitled "Woman's Kingdom." She did not share Joe's pride in Copper Cliff, and often reminded her readers of how she felt. Giving her address as "The Shack, Blast Alley," she wrote paragraphs such as:

> The merry sound of the hammer and the saw is heard throughout this bit of North land. Everyone seems to be building or "leaning-to", or something. It is bustle from morning till night with the belled cows "rubbering" along in the early mornings shouting for lost calves, and the pigs rooting briskly and the hens chuckling.
>
> Let me inform you — you lack live news down east there — that we have a very fine club-house here (with one night a week for ladies — isn't that generous!) a Bank of Toronto — no less! with a most popular manager, and teller — to say nothing of the junior (small "j" printer, please) and many other dissipations. Likewise (this is an important item), a verandah has been built around the doctor's house.

Sudbury, Copper Cliff and Creighton still were remote towns in the laboratory of the Canadian Shield. Prospectors still roamed the Shield; government surveyors still mapped the long miles of inhospitable rock and muskeg stretching north from the shores of Superior and Huron to James Bay. At the same time the International Nickel Company was formed, government surveyors announced the discovery, forty or fifty miles north of Thessalon, and one hundred and twenty-five miles west of Sudbury along the Mississagi River, of a stand of white pine.

"In some places, it extends for thirty miles along the river, and as far as the eyes can reach," read the report,

and estimated "in places, the belt would contain five to eight million feet, per mile."

To the north of Sudbury, also by one hundred and twenty-five miles and in the townships of Tisdale, Deloro, Whitney and Ogden, government surveyors and geologists were reporting the presence of gold and silver deposits. It was not new information.

In 1896, E. M. Burwash was examining the district for the Ontario Bureau of Mines, and he reported quartz veins that carried gold; in 1899, while mapping a portage route from the Metagami River to Night Hawk Lake for the Bureau of Mines, W. A. Parks noted gold, and wrote, "I regard the region south of the trail to Porcupine Lake as giving promise to the prospector"; in 1901, Charles Camsell* later was prospecting for the Algoma Central Railway, examined a vein and registered his find with that company.

It was exploration that preceded the staking out of the great gold and silver deposits of the Porcupine area. They were deposits that, within a few years, would attract Ambrose Monell and his associates. Monell's immediate interest was to find ways to extract more and more of the mineral contents from the Sudbury ores.

*One of the builders of the Canadian north, this is the Camsell who gave the last years of his service as Deputy Minister of Mines for the Dominion government.

10

The New Metal Was Unique

I graduated from Columbia University in New York City in 1903 as a chemist, but I did not want to be a chemist. I wanted to be a metallurgist. With a view to becoming a metallurgist, and to keep myself in funds, I got a job teaching in the School of Mines at the university. In almost no time, I was sure I wanted to be a metallurgist, but wanted more to be a teacher of metallurgy.

Having made this decision, I realized if I was to continue to teach an applied science, it would be well to get some practical experience to add to my classroom knowledge. With that in mind, I put out some feelers for a job. I was offered a couple of jobs, but turned them down. One day I was coming from lunch at the Faculty Club, and I ran into Professor William Campbell. He was a Scot who came to the United

States on a fellowship, got a Doctor's Degree at Columbia, and was teaching there. I was associated with him. He was a good friend to me, and to a generation of students at the School of Mines. Also, he was one of those serious-visaged Scots who love to joke. One never knew from his voice, or from his face, if he was fooling or if he was serious.

As we met, he paused, saying: "I'm glad to see you're coming back with us."

I wasn't coming back, although there were rumors to that effect. So I said, "I'm not coming back but I am going to quit." Campbell walked on, stopped suddenly, turned around, and asked: "Are you really going to quit, Jack?"

"Not only that, but I'm looking for a job."

"What kind of a job?"

I told him I had been offered two different jobs, of not liking them, and said, "Do you know where there is a job?"

He nodded. "The Nickel Company down in Bayonne is going to put in a research laboratory, and they're looking for a man." I asked: "Do you know anyone there to whom you could give me an introduction?" He shook his head. "I don't know anyone," and started to walk away.

I stopped him. Dropping into his kidding habit, I said: "Everybody knows you, Bill. Your name is probably the best-known name in American metallurgy. What you ought to do is to call the president of the company, right now, and tell him there is only one man for the job, and he'd better move fast, or he isn't going to get him." Campbell laughed, and went on, calling back over his shoulder: "I'll do that before I go to lunch."

I left the building, sort of chuckling to myself over my own childish joke and Campbell's quick rejoinder.

When I got back to my office, a telephone message was waiting.

In effect, the message read: "Mr. Monell, of the International Nickel Company, called, and would like to see you this afternoon, if possible."

Riding downtown on the elevated railroad from the university I got to thinking about two men whom I had known and who had been associated with the company. One man was Professor Henry M. Howe, whose assistant I had been for three years. Probably, he was the greatest library metallurgist of his day. I mean he would have been a great judge or theologian. He was a great teacher. He had a magnificent mind, but I have never been able to think of him as a practical man in the sense of handling a business, or people, or things of that sort. The other man, who had been Howe's assistant at the Orford Works, was Professor E. D. Peters, of Harvard University. For him, too, I had the greatest respect.

Thinking about those two men I felt it might be a place where I wanted to work. After I talked with the Nickel Company, I knew it was. I started on July 17, 1906.

j. f. t.

WHILE Monell was working on his processes, he was thinking in terms beyond the capture of the nickel and copper in the Sudbury ores. In the ores were gold, silver, platinum and other elements. It was Monell's hope to recover the precious metals. It was not a new search.

Robert M. Thompson had knowledge of the presence of precious metals in the ores. He also knew that in the Orford Process most of the gold and silver rose to the

"tops" with the copper, and most of the platinum and palladium remained in the "bottoms" with the nickel.

He tried to separate them, and had some success. The success was confined to partial recovery of platinum and palladium. Hoping for results that never came, Thompson set aside a section of the plant and called it the Platinum Refinery.

It was not until the technical talents of the Canadian Copper Company and the Orford Copper Company were brought together with the formation of the International Nickel Company that there began to be real progress in researching into the properties and uses of Canadian ores. Prior to the merger, recovery of a substantial portion of the precious metals, or an identification of all the elements in the Sudbury ores, was beyond the reach of the metallurgical processes then employed.

With the formation of the International Nickel Company attention became focused on better ways for producing nickel, and for the recovery of the other metals in the ore, particularly the platinum metals. Influenced by Hybinette and David H. Browne, the company began investigating electrolytic refining methods. Monell recognized, as did the chemists, that refining by electrolytic methods promised (1) a better quality of nickel and (2) a higher recovery of platinum and palladium from the nickel "bottoms."

Several months afterward, a number of reports were submitted. Among the reports was one prepared by Albion J. Wadhams, of the Orford Copper Company. With the report, Wadhams submitted a sample of a material produced in the plant. The sample contained two elements previously undiscovered in the ore.

The elements were rhodium and iridium. Like palladium, they were members of the platinum family. Remaining for discovery of the fourteen elements* in the Sudbury ores were ruthenium, selenium, and tellurium.

Work was started on designing and building new equipment, but before the new equipment was in place in the Constable Hook plant, Robert C. Stanley was transferred from the American Nickel Works to Orford as assistant general superintendent. It was an important change. A graduate of Stevens Institute of Technology and Columbia School of Mines, Stanley soon disclosed the quality that was such an essential part of his character.

After graduating from the Columbia School of Mines in 1901, Stanley went to work for S. S. White Dental Company where he conducted experiments on the strength of palladium-gold alloys and gold-platinum alloys. In connection with the tests, he was sent to Black Hills, South Dakota, to look over some mining properties. At about the same time, Albert W. Johnston, an officer in the dental company, became an officer of the Orford Copper Company and brought Stanley with him.

In 1904, before the American Nickel Works of Camden and the Orford Company were merged, Stanley was transferred to the Orford plant in Constable Hook (now Bayonne) as assistant general superintendent. As such, on December 30, 1904, he sent the following letter to the Sales Manager:

*The fourteen elements presently recovered from the Sudbury ores are: nickel, copper, cobalt, iridium, ruthenium, rhodium, palladium, platinum, gold, silver, selenium, tellurium, iron, and sulfur.

The Orford Copper Company,
43 Exchange Place,
New York, N. Y.
Mr. F. S. Jordan.

DEAR SIR: Will you kindly make requisition to the Canadian Copper Co., for one car Bessemer matte free from iron, or blown down to as low iron content as possible. We wish this for experimental purposes and would like same as soon as possible.

ROBERT C. STANLEY

The matte came. Stanley went to work. Prior to this time, in producing most copper-nickel alloys, technicians had separated the copper and nickel and then recombined them. Stanley believed, as did David H. Browne and Victor Hybinette, that a copper-nickel alloy could be produced without separating the metals.

Thinking in terms of a more economical way to produce nickel (German) silver, Browne had gone up the same road Stanley was on, and along which Hybinette had traveled. To produce nickel silver at less cost than by the usual melting of three metals (copper, nickel and zinc) Browne had become convinced that oxidation of the nickel-copper matte and the reduction of its oxide with charcoal, without previous separation of the two metallic sulfides, would provide a molten copper and nickel alloy to which zinc could be added.

The idea seemed so practical that Browne turned it over to Hybinette at the Orford works in 1903, or perhaps early in 1904. In use at Orford was a calciner furnace from which Hybinette demanded the maintenance of a stipulated daily production schedule, whether the material being roasted was nickel-copper sulfide matte, or nickel sulfide. For some strange reason, because he was an able metallurgist, Hybinette did not realize that the nickel-copper sulfide would begin to oxidize at a lower temperature than nickel sulfide, and if initial melting of the matte took place before there was adequate oxidization a sulfur-free oxide would not be produced.

As a result, the matte reached the hot discharge end of the calcining furnace in a partly roasted condition, melted and ran out the front doors of the furnace — but was not free of sulfur. Hybinette attempted this direct calcination a number of times, and always with the same results. Finally, he gave up.

Picking up where Hybinette left off, Stanley talked over this experience with associates at Constable Hook and decided to continue the experiments, but under controlled conditions. Satisfied that he knew the reason for Hybinette's failures, Stanley instructed the calcining furnace foreman to process the material in a way that would ensure the highest possible removal of all sulfur without regard to the amount of daily production.

Taking a sample of the resultant oxide to the nickel refinery building, Stanley reduced and melted it with charcoal in a crucible. When the metal was molten, Stanley added magnesium, cast it into a small ingot and forged it into a bar. After cooling, he heated it again, this time to a temperature of 180° F., and bent the bar. Satisfied that the metal was sound as well as ductile, he turned over the forged and bent specimen to R. R. Maffett, superintendent of the Orford Copper Company, who took it to New York to show Monell.

Stronger than mild steel and more resistant than bronze to salt water and sulfuric acid, the new alloy

was so outstanding among metals, and so promising, that Professor William Campbell, of Columbia University, was engaged to evaluate its properties. The report was most encouraging. It agreed the new metal was unique, and that it had many potential uses, among them in pickling equipment for steel mills, castings for oil stills, roofs of buildings, propellers for ships — there were many indicated uses. In honor of the president of the company, an application was made for use of the name Monell as a trademark for the new product. The application was turned down in Washington since the use of a family name for trademarking purposes was not permitted by the United States Patent Office. One of the "l"s was dropped in a second application. This application was approved.

Having no facilities for production, the company arranged with the American Sheet & Tin Plate Company (Vandergrift, Pennsylvania) and later with the West Penn Steel Company (Brackenridge, Pennsylvania) to make sheets, with the Crucible Steel Company (Harrison, New Jersey) to make rods, and with the Central Iron & Steel Company (Harrisburg, Pennsylvania) to make plates. In 1907, half a million pounds of the alloy were sold; in 1908, the company made its first large sale. It sold 264,000 pounds of Monel sheets for the roof of the Pennsylvania Railroad Station in New York City. The installation was completed in 1909. After more than fifty years of use, the roof appears good for at least another fifty years.

The resistance of Monel nickel-copper alloy to the action of sea water, to acid and alkaline solutions and to atmospheric corrosion, along with its high tensile strength, attracted the attention of the United States Navy in much the same way nickel steel had attracted its attention some twenty years earlier. The battleship *North*

Dakota was equipped with Monel alloy propellers. Three-bladed wheels thirteen feet in diameter, weighing 15,000 pounds and cast in one piece, they were so satisfactory after a service of twelve months that two spare propellers were ordered.

More than forty propellers were made for other Navy ships; in addition, a dozen and more propellers were ordered for ships of the Argentine, Italian and Japanese navies.

But, despite the great interest of governments in the Monel alloy, its introduction into commercial markets was not quite as easy as falling off a log.

There was a natural reluctance to trying something new. Steelmakers had no taste for rolling it. It was tough to cut, and it was harder than steel to roll. It was very difficult to cast. To remedy this last deficiency, a separate company was formed. It was called the Bayonne Casting Company. In Bayonne, in an old stable, was a small foundry. The Bayonne Casting Company took over the foundry, and began making and selling its own products. Maffett was in charge of both operations.

Although containing 67 per cent nickel and 28 per cent copper, it was placed on the market at about two cents a pound above the current price for copper. This was believed possible because of the anticipated savings resulting from the elimination of the process of separating the copper and the nickel. Besides, there was the natural desire to attract the reluctant order.

In 1909, production of Monel nickel-copper alloy at the Bayonne Casting Company's plant amounted to about 12,000 pounds; in 1913, production exceeded 280,000 pounds. Largely responsible was James Francis McNamara, who took a job with the Casting company on

the eleventh day of the eleventh month of the year of 1911. McNamara had tried his hand at many things, including prize fighting, cooking, running a restaurant, and selling subscriptions for magazines.

It was as a door-to-door salesman that McNamara introduced himself to Alex Comrie, who owned a small blacksmith shop on Staten Island. Almost before he knew it, Comrie had paid for a subscription for a magazine he really didn't want; and almost before he knew it, McNamara had a new job.

In his blacksmith shop, Comrie had a section where he displayed, and sold, Monel nickel-copper alloy golf clubs made from castings he bought from the manufacturers. McNamara became a salesman of golf clubs. This was in 1910.

McNamara was successful in selling golf clubs, but Comrie was not successful as a businessman. He closed his shop and both men went to work for the Bayonne Casting Company. Within a few years McNamara was managing the Casting company.

At the Nickel Company it was beginning to be seen that the development of new alloys requires sound ore reserves, large and efficient production, skilled and experienced distribution supported by ample research and technical review.

Roughly, these were also the years of great further advances by alloy steels.

In 1893, four years after the publication of James Riley's famous treatise *Alloys of Nickel and Steel,* the Ferris wheel at the Chicago World's Fair was getting extra attention because it had a nickel steel shaft; in 1898, the Whitney Manufacturing Company of Hartford, Connecticut, was advertising bicycle sprocket chains of 5 per cent nickel steel.

And on December 17, 1903, at a spot four miles south of Kitty Hawk, North Carolina, and for the first time, a heavier-than-air machine, carrying a man, raised itself by its own power and took off in full flight. The airplane, built by Wilbur and Orville Wright, contained chromium nickel steel in the engine.

In 1903, the company spent $50,000 in financing a study by J. A. L. Waddell, an authority on bridge engineering, into the suitability of nickel steel for bridge building. Unfortunately, steelmakers, bridge builders and public officials were not persuaded by Waddell's reasoning—nor was the Publication Committee of the American Society of Civil Engineers. The committee rejected a paper on the subject. Later, parts of the paper were published, but records concerning expected economies in bridges built of nickel steel were deleted; retained were records concerning structures built of mixed nickel steel and carbon steels.*

The Queensboro Bridge which spans the East River and connects the boroughs of Manhattan and Queens in New York City was built in 1909. A double cantilever structure with two main spans of 984 and 1,182 feet, it was the first application of nickel steel in bridge construction. The controversy that surrounded its building soon faded, so convincing were the advantages of nickel steel. And, as bridge builders and steelmakers and public authorities learned more about the uses of nickel steel in bridges, so did the company learn more about its own product.

*In 1909 the paper appeared in its entirety in the *Transactions* of the society, and was awarded the Norman medal, as being the best paper of the year.

By 1910, practically all steel companies were using their catalogs to tell of their nickel steels.

Taking shape at International Nickel was the operation that, later, would be called the Technical Service Division. Set up about 1907, its first real function was to answer questions concerning Monel nickel-copper alloy.

In large part, they were questions that could not be answered. Instead of trying, the company sent out samples of the nickel-copper alloy and suggested to the inquirers that they "use the metal, and find out what happens." Careful track was kept of the samples and, wherever possible, the company sent representatives into the shops to work with prospects in developing uses that would justify, economically, the inclusion of the higher-cost material.

Out of these beginnings in field tests came Technical Service; and, along about 1910, began another important development — a distribution system. Learning through experience that older distribution organizations were not interested in exploiting the little-known Monel alloy, the company made it a practice to seek out smaller, and newer, distributors who were anxious to co-operate.

It made for a good relationship. The smaller and newer distributors had enthusiasm; they knew markets and manufacturers in their own areas, and they had warehouses from which the metal could be made available to local customers; for its part, the company could supply information, and back it up with technical help.

The soundness of these early activities was proved following World War I when the company had to develop commercial products if it was to remain in business. After the war, the number of alloys expanded greatly, but the early experience provided the foundation for the extensive research, development and service activities that have become so important in making nickel more useful in carrying the load its employment naturally creates.

On September 5, 1912, the then parent company (incorporated in New Jersey) was reorganized with an authorized capital of $62,000,000 and its name changed from International Nickel Company to The International Nickel Company. By this action, it ceased being a holding company and became an operating company.

In the reorganization the company took over all the assets and liabilities of The Anglo-American Iron Company and the Orford Copper Company, with which had been merged the American Nickel Works in 1905. The Vermillion Mining Company was absorbed by the Canadian Copper Company on December 31, 1911. The two New Caledonia companies which had been brought into the original consolidation, as well as the Canadian Copper Company, were wholly owned by The International Nickel Company.

The Huronian Company, Limited, which was to become another subsidiary, was a power development at High Falls on the Spanish River, was incorporated in 1902 by special act of the Ontario government, and was the first hydroelectric plant in the district. Located about twenty miles west of Sudbury, Robert M. Thompson helped pick out the site, making the trip on snowshoes from Copper Cliff. In 1917, the Huronian company began a second power plant, also at High Falls, and about five miles west of the Victoria mine which was closed by the Mond Company in 1913. Five years later, or in 1918, the operations of the Canadian

Copper Company were taken over by the now parent company.

In the years since the formation of the parent company in 1902, there had been some changes in management, but not many. In 1916, the executive officers were: Robert M. Thompson, Chairman of the Board; Ambrose Monell, President; E. F. Wood, First Vice President; J. R. DeLamar, Second Vice President; W. A. Bostwick, Assistant to the President; James L. Ashley, Secretary and Treasurer; James W. Beard, Auditor.

The directors were: Robert M. Thompson, Ambrose Monell, E. F. Wood, J. R. DeLamar, William Nelson Cromwell, Alfred Jaretzki, S. H. P. Pell, Edmund C. Converse, William T. Graham, Willard H. Brownson, Seward Prosser, W. A. Bostwick, James L. Ashley and W. E. Corey. One famous name was missing — Charles M. Schwab.

The headlines came quickly. On August 1, 1914, Germany declared war against Russia; on August 3, Germany was at war with France; a few days more and German armies were crossing Belgium, British soldiers were at the side of French troops in France; in Canada bugles were calling, urgently. Before many weeks angry voices in the Dominion were shouting, "Canadian nickel is being shipped from the United States to Krupps to be made into bullets for British soldiers."

Slowly, the clamor subsided, but became an uproar with the announcement by Germany that the submarine *Deutschland*, which arrived in Norfolk, Virginia, on July 9, 1916, had returned to Germany with a cargo of hundreds of tons of critically needed supplies, including refined nickel.

The Dominion government was in a difficult position; so was The International Nickel Company. After much thought, and much discussion, the Dominion government made public the facts. In a speech in Toronto, November 23, 1916, the Solicitor-General said:

". . . Everyone knows that nickel is one of the vital elements of war supplies. Consequently on the outbreak of war, the question confronted us as to how to handle the nickel of our country so as to serve best the interests of the land we love and starve the interests of our foes in the war. We could, insofar as our constitutional and legal powers went, have prevented absolutely the exportation of this metal. . . .

"But we were confronted with the truth — which no one who regards truth at all will fail to recognize — that were we to prevent the exportation of matte, a year and a half must elapse before there could be more nickel refined for the use of our own friends and Allies in the war. That was a contingency and result which no sane Government could invite, which no sane Government could possibly allow. Had we taken that course there could be no battle of the Somme today. It might be that there would be none of our nickel get to Germany. Even so she would still have had vast reserves and many sources of supply pressed into service by war. But a far worse disaster would have come — our nickel would not have got into the hands that it must get into if we are going to win this war. . . ."

The fact was the amount of nickel smuggled aboard the *Deutschland* was small.

* * *

On July 25, 1916, The International Nickel Company of Canada, Limited, a subsidiary, was incorporated under

the Dominion Companies Act. On August 24, 1916, the directors of the Canadian subsidiary made an initial appropriation for the purchase of land, and the building of a refinery at Port Colborne, Ontario. The refinery was built and went into operation in the latter part of 1918. With the opening of the refinery, all assets of the enterprise in Canada were transferred to The International Nickel Company of Canada, Limited.

11

Stanley Takes Over

WITH the entrance of the United States into the war on April 6, 1917, the restless, sensitive Ambrose Monell offered his services, and was commissioned in the rank of colonel in the Signal Corps.

News of his enlistment brought editorial comment, much of it in vein similar to what was said in the *Engineering and Mining Journal,* this being that few realized that the contribution was made at "great personal sacrifice [for] in severing his connection with the only great nickel company in the world, Monell gave up not only a respectable salary attached to the position, but also the bonus he received for his services in creating new uses and demands for the metal."

The editorial was intended as praise, but it was not accurate. In offering his services Monell had no sense

of heroics. In the presence of the question, "With my country at war, where do I belong?" things such as salary and position and bonus had no meaning. His concern was the welfare of his country.

In uniform, Monell was a supply officer for the Aviation Section of the Signal Corps.* It was a section which consisted of 131 officers, mostly fliers, 1,087 enlisted men, 250 airplanes and five balloons. In the section was only one fully organized and equipped combat squadron, and even these planes were not combat-ready as compared with European types.

It did not take long for Monell to familiarize himself with the supply needs of a rapidly expanding service, but he could not accustom himself to the sanctity of military chain-of-command, or to the red tape of government. One day, in Paris, Henry Gardner, of Henry R. Merton & Co., called on Monell to find him storming about the stiffness of officialdom, and heard him grumble: "I'm going to see General Pershing, and I am going to put on a high hat."

"Whatever for?" asked Gardner.

"Well, if I went in uniform, I couldn't talk to him the way I intend to."

Returning to New York after the war, he came to his office infrequently. Having become interested in politics,

*On May 21, 1918, President Woodrow Wilson removed aviation from the Signal Corps to the newly activated Bureau of Aircraft Production and the Division of Military Aeronautics. The two new agencies were placed under the Secretary of War.

The Bureau of Aircraft Production was given "full and exclusive jurisdiction and control over production of aeroplanes, engines and aircraft equipment" for the Army.

The Division of Military Aeronautics was made responsible for training and operations. On May 24, 1918, the two agencies were officially recognized as the Army Air Service.

On August 27, 1918, President Wilson put them under one head and appointed John D. Ryan, former president of the Anaconda Copper Company, as Director of Air Service and Second Assistant Secretary of War.

he spent a lot of time and effort in promoting the candidacy of General Leonard P. Wood for the Republican nomination for the Presidency of the United States. Bitterly disappointed when Wood lost the nomination to Warren G. Harding, Monell's visits to the office ceased almost entirely. He died May 2, 1921.

The war brought changes in the top management of the company. With Monell in uniform, W. A. Bostwick became President. E. F. Wood resigned as First Vice President to become a member of the War Industries Board, and Stanley became First Vice President. He was given general control over Operations, Construction and Engineering. The war was over in November 1918. In that same year, the Port Colborne Refinery went into operation. The cost of building it was approximately $6,000,000.

In the year ending March 31, 1918, sales of nickel in all forms totaled 71,354,000 pounds. In 1919, sales were 62,018,000 pounds; in 1920, they totaled 36,587,000 pounds; in 1921, they were 29,870,000 pounds; and in 1922, they totaled 12,804,000 pounds—a loss of 58,550,000 pounds in four years. The 1922 sales were not much more than the sales of the Orford Copper Company in 1901.

An operating man, Stanley long since had turned his attention to the problems that would confront the company in the postwar period.

When the United States entered the war, the demand for nickel was such that practically all orders were listed as priority items for nickel to be used in the manufacture of ammunition, ordnance, armor plate, guns, gun mounts, etc. — and a study of the order books disclosed that for twenty years the steady increase in nickel sales had been

due, almost entirely, to the competition between nations in the building of armaments.

In the late summer of 1918 it seemed to Stanley that the end of the war was not far off. Satisfying himself that almost all of the company's production of nickel had been going into war matériel he began to make plans after giving a lot of thought, and discussion, to Inco's place in future markets.

Looking at Monel nickel-copper alloy, a product already at hand, he saw more than just an alloy. He saw an industry. Since 1905, when the first ingots were produced at the Orford Works, the conversion of these Monel alloy ingots into rods and sheets had been done at outside steel plants or brass mills.

Also, since 1905, there had been a number of occasions when company executives gave serious consideration to dropping the alloy altogether — so few were the sales, so slow was recognition — and, each time, the one obstacle that stood in the way was the fact that the trademark for the alloy had been derived from the name of the company's president.

Unfortunately, and not long after succeeding Monell as president, Bostwick's health began to fail. Characteristically, Stanley sought the counsel of those who went with him from Bayonne to New York in 1917. In Bayonne they were the people he always talked with in time of decision and who, when confronted with personal problems, always talked with him. It was a carry-over from the years when they had sat together, the way people do in a plant, telling each other what they would do if they were in the front office and running things.

They were not people who were salesmen in the usual sense of the word. They were people who were so interested in nickel that they thought in terms of markets, rather than in terms of just selling a piece of merchandise. They were sure they had done no more than tap the market for Monel nickel-copper alloy, or for nickel; and it was their complete belief that the markets for their metals would have to be made less vulnerable to the circumstance of armaments.

At 11 o'clock in the morning of November 11, 1918, the guns were silent. There was a ceremony of surrender in a railroad coach near Compiègne, but it was not peace. It was armistice, an armed truce. In this uncertain climate, the Allied governments kept in force all contracts for munitions, so that it was not until February 1919 that the demand for nickel began to slacken.

Wishing to strengthen the research organization, Wadhams went to Stanley with a proposal to set up a Development and Research Department. Stanley liked the idea, and asked Wadhams if he had any suggestions as to personnel. Wadhams shook his head, whereupon another who was present proposed Paul D. Merica, a physicist employed by the Bureau of Standards, in Washington, D. C.

Educated as a chemist and metallurgist in DePauw University, Greencastle, Indiana, the University of Wisconsin and the University of Berlin, Germany, it was Merica's work as a research physicist with the Bureau of Standards that first attracted international attention. Not yet thirty years old, he became known for his development of a theory for the hardening of metals and alloys through precipitation. It was a discovery that opened a new frontier in physical metallurgy. On April 1, 1919, Merica joined the company as a physical metallurgist.

Stanley saw in Merica another who could help in creating products that would be useful in making the

company less dependent upon the purchases of governments; and, with this in mind, set out to do two things:

1. To further extend the uses of nickel in already established civilian markets; and
2. To develop new uses for nickel, especially in fields not occupied by it.

Realizing that if the commercial possibilities of Monel alloy were to be developed, International Nickel would have to build a rolling mill, Stanley also realized that if production was to be brought closer to distribution, a program would have to be organized to include active sales work and advertising effort, as well as research and engineering services. In a period of declining sales, it was an approach that had to be made a step at a time.

The first step was the building of a rolling mill, but before that could be done a number of uncertainties had to be considered:

1. Potential markets;
2. Minimum equipment necessary to meet present requirements and requirements of near future; and
3. Cost of product as compared with cost and quality of product produced under contract arrangement with outside mills.

A survey was made, and these conclusions were reached:

1. That existing and prospective business for Monel nickel-copper alloy justified the estimated capital expenditure of approximately $3,000,000 for a rolling mill to produce rods and sheets.

2. That the potential markets for Monel alloy and other nickel alloys were such that the plant should be laid out with provisions for considerable expansion.

3. That natural gas, being practically free from sulfur, is the ideal fuel for heating purposes. Should it be necessary to utilize producer gas, the estimated capital expenditure for plant and equipment would be increased by approximately $200,000.

4. That the particular disposition and service of the merchant and sheet mills was such that the individual electric drive, with gear reduction when necessary, would be best.

5. That purchased electric power was preferable, and if not available, capital expenditure would be increased by approximately $750,000.

6. That at least twenty, and preferably up to fifty, acres were advisable for a site.

A. S. Shoffstall, research engineer, and W. L. Wotherspoon, executive engineer in charge of engineering and construction, were named a committee of two to select a suitable location. These two men made a good team. Wotherspoon, an English-trained mechanical engineer, had worked in the gold mines of South Africa and in the mining district in Canada; Shoffstall was a chemist and metallurgist who, after teaching at Pennsylvania State College and a short experience in chemical manufacture, entered the employ of the Nickel Company in the early days of Monel nickel-copper alloy.

Their choice was Huntington, West Virginia. On May 13, 1920, Stanley wrote to Bostwick recommending

the expenditure of $3,000,000 to construct a sheet and rod mill for rolling Monel alloy and saying:

1. That, as a result of enlarging our smelter and refineries to meet war time demands for nickel, we now have a surplus capacity beyond estimated requirements of the world's markets for some years to come.

2. In order to use this idle capacity and produce material required for commercial uses rather than armamental, we have inaugurated an extensive advertising campaign which is developing a large demand for Monel nickel-copper alloy in wrought form. This we are unable to produce ourselves or to obtain on a toll basis from other mills, although we have ample ingot capacity in our refineries.

3. We could now sell 500,000 lbs. Monel sheets per month, but we are unable to obtain any tonnage from outside mills although we have thoroughly canvassed the field.

4. We are now selling from 300,000 to 500,000 lbs. per month of Monel rods and bars, which are rolled by the Crucible Steel Company, and cost us 10¢ per pound above our ingot costs.

5. Since neither the production of rods nor sheets is directly under our control, it is impossible to improve the quality of our product, and this seriously curtails sales expansion. . . .

In the same document, Stanley urged Bostwick to delay taking any action. It was Stanley's belief that with the costs of construction falling rapidly, appreciable savings could be made by waiting. After a wait of nearly ten months, Stanley was satisfied costs had reached a stable level. On March 7, 1921, the Executive Committee approved his request. Work was begun.

On March 10, 1921, Stanley made another proposal. He wrote to Bostwick, saying:

> Unless we anticipate a prompt revival of business far in excess of our pre-war volume, it is not only advisable but absolutely necessary to limit our nickel refining to one works. . . . Without going into detail, it is my opinion that a great saving could be effected by the elimination of the Bayonne Works, concentrating our nickel refining at Port Colborne and our Monel refining at Huntington. . . .
>
> I realize that this is a serious matter to contemplate, but at the same time I am firmly convinced, viewing the matter from an operating standpoint, that we are making an inexcusable mistake in maintaining a divided refining capacity of eight million pounds per month, whereas by a radical change we could concentrate to a single operation of four million pounds per month (with prompt expansion if necessary) which will undoubtedly meet our requirements for years to come. . . .

As Stanley said, closing the Bayonne refinery was a serious matter. Closing it meant shifting people to Port Colborne, finding jobs within the organization for other people, pensioning others and releasing the remainder. It took time to discuss these things, and to reach a decision — and especially under the conditions which existed did it take time. Bostwick was away from the office a great deal, because of illness.

On November 26, 1921, events forced a decision. On hand were large accumulations of nickel, of matte and of

intermediate products in which the metal was sealed. In the Sudbury district the mines were closed.* Cash was running low. Stanley wrote and, with Bostwick, signed a memorandum to the Executive Committee calling for further reductions in operating costs — "a minimum of $25,000 a month," said the memorandum.

Payrolls again were cut. In November, in the Sudbury district payrolls were down to $23,000 from $134,000 in January; in Port Colborne, to $11,000 from $23,850 in January; in Bayonne, to $20,210 from $64,120 in January.**

The recommendation, which was approved by the Executive Committee, was among the last documents signed by Bostwick. He died on February 4, 1922.

When Stanley became President of International Nickel on March 2, 1922, Charles Hayden was elected Chairman of the Board of Directors, succeeding Edmund C. Converse, who had died on April 4, 1921. The naming of Hayden was a move which certified the company's financial standing by placing a banker of international reputation in a top position.***

With Stanley's elevation to the presidency, there was

*On May 1, 1922, the refineries were reopened. The mines were reopened in the following September.

**A casualty of this period of depression in the nickel business was the British America Nickel Corporation, Limited, incorporated July 2, 1913. Most of its assets were the carry-overs from unsuccessful earlier promotions in the Sudbury area. The company did not get into production until the war was virtually over. The extreme depression in the nickel industry compelled it to shut up shop in 1921. After a brief unsuccessful attempt to begin operations again in 1923, the company went into bankruptcy in 1924.

***At the time of his death on January 8, 1937, Charles Hayden, senior partner in Hayden, Stone & Co., investment bankers, was a director in 58 corporations. He left almost his entire estate of $50,000,000 to establish a charitable foundation for the education of youth and the advancement of their "moral, mental and physical well-being." Among his gifts to the public is the Hayden Planetarium, in New York City.

a big shift in personnel. Almost everyone ended up in a different job. A technical man became manager of a newly created Operations Department; a plant superintendent became director of development and research; and so on. It was one of those times in the life of a company when there were no departmental lines. But it was a shake-up that turned out well. At a critical time and under the leadership of a man in whom all had complete confidence, all were united in the pursuit of a common objective.

In New York were gathered people who were able to talk catch-as-catch-can on any phase of the nickel business. It helped to make up for the lack of regular salesmen, of whom there were two.

Operation-minded, Stanley was of that breed of men (there always are a few in each generation) who are willing to take the risk, win or lose, in backing up an idea; and, win or lose, to keep on risking. It was this trait that caused him to urge the spending of more than $3,000,000 for the building of a rolling mill at a time when $3,000,000 was almost all the money the company had in the bank — the same trait that now was causing him to organize a Development and Research Department, and to insist upon a sales and advertising program for a product that, in the past, had been put on a shelf and kept there, waiting for somebody to come and buy.

It was Stanley's oft-stated belief that in industry, research and development operations are job-insurance policies for the employees and dividend-insurance policies for the stockholders. Prior to Stanley's promotion, research was confined almost entirely to nickel-copper alloys, although there had been a few side trips into producing malleable nickel and, during the war, the making of copper-nickel alloys, especially one called Constantan.

This was an alloy (55 per cent copper and 45 per cent nickel) which was used in electrical instruments.

The fact was that while the world's annual production of nickel had risen from 1,000 tons in the eighteen-eighties to 50,000 tons in 1918, the stockpile of knowledge about nickel was far short of what it should have been. With this lack of knowledge in mind, the following plan of action was laid down for the Development and Research Department:

1. Develop active engineering and technical contact with engineering and technical personnel of actual, or potential, nickel-using industries — steel industry, automotive industry, etc. — this to be done (a) to understand the materials problems of those industries, and (b) to discuss ways in which nickel products can be used by them to their advantage.

2. Develop first by laboratory and plant research, new nickel products in fields where currently used products might be inadequate, or non-competitive, and to invent, where possible, new nickel products to meet new industrial needs.

3. To introduce new nickel products, whether developed by our own research, or by outside research, through technical meetings with representatives of industry.

4. To provide educational articles for the technical press, and for distribution to engineers and technical men on the properties, on the engineering aspects and uses of nickel products.

5. To provide consulting and technical services with respect to nickel products to actual, or poten-

tial, users covering such subjects as properties of nickel products, fabrication of nickel products, their welding and machining, and their corrosion-resisting performance, to establish their suitability for industrial applications.

A research laboratory was set up in an abandoned frame house in Bayonne. The equipment consisted of a couple of tensile-testing machines, a scleroscope and Brinell hardness tester, a small melting and two small heat-treating furnaces, a couple of microscopes, a metallographic camera with tennis balls fixed under the legs to absorb vibration, a dark room, beakers, Bunsen burners, bottles of chemicals – not much in the way of apparatus, but a great deal in the way of a most important ingredient, brains.

Of course, the researchers had a wonderful metal to start with – but neither they, nor anyone else, yet realized how wonderful.

In New York, engineering specialists were assigned to developing a community of interest with users and possible users of nickel, supplying technical information and rendering technical services to all who asked, or needed, such information and such services. Co-operating in the program was the laboratory in Bayonne which was established to serve the needs of industry, and to anticipate its trends.

While the military demand for nickel had almost disappeared, not only because of the cessation of hostilities but as the result of the Washington Disarmament Agreement of 1921, good soil was waiting. The war had destroyed a lot of prejudices. Among engineers generally,

there was much greater appreciation of the alloy steels, the special alloys, and the values in the newer materials.

One of the cheapest materials was cast iron, long regarded as a material upon which no extra costs should be placed. Merica set out to demonstrate that nickel could bring real advantages to cast iron in the form of better and uniform properties. Experimenting, he found that "gray cast iron suffered from the dilemma that when ordinary steps were taken by adjustment of composition, or otherwise to improve its strength and hardness, the machinability of the iron (a most important characteristic) was impaired and thus a limitation was imposed thereby on improvement of cast iron strength and hardness.

"It was found that by the addition of small amounts of nickel, together with concurrent changes in the silicon and carbon contents of the iron (which generally were lowered) substantially increased values of hardness as well as strength in gray iron could be obtained without impairment of machinability."

The long studies which brought about the great advance in the usefulness of cast iron were complex, but cast iron itself is a complex substance.

One laboratory development of great interest to foundrymen was a hybrid cast iron marketed under the trademark Ni-Resist. This material was a nickel-copper cast iron which blended the cheapness and easy handling of cast iron with durability and toughness and also resistance to heat and corrosion in a wide variety of corrosives. Automobile engineers were quick to recognize its special merits because of its close match in thermal expansion properties with those of aluminum-silicon piston alloys.

Before 1926, the automobile industry was consuming approximately 30 per cent of Inco's nickel production. It was an important market, but not dominant. Instead of four items — plating, coinage, nickel silver and nickel steel — as before the war, there were eleven items, in addition to Monel nickel-copper alloy, and several of the eleven items were considerably diversified. The eleven items were:

Structural nickel steels, nickel silver, coinage and copper-nickel alloys, nickel plating, heat-resisting alloys, Edison storage batteries, malleable nickel, ferronickel alloys, nickel cast iron, nickel cast brasses and bronzes and catalyst for the hydrogenation of oils.

Directly the result of research into the principles and factors involved, nickel plating was changing from an art to a science. This was a development that was due to research work in the United States Bureau of Standards, and in universities, as well as to work within the industry. Also, it was a development of importance to the automobile industry, as well as to the general hardware trade, to electrotypers and to whatever users there were for nickel-plated articles.

When the Armistice was signed, the commercial uses for heat-resistant and electrical chrome-nickel-iron alloys were limited; in 1926, these alloys were accounting for more than 2,000,000 pounds of nickel each year in the United States and Canada. Nearly a score of companies were producing and selling them. The alloys carried different trade names and contained from 5 to 80 per cent nickel, 13 to 25 per cent chromium, and from little to 70 per cent iron, depending upon the use.

They were referred to as "heat-resistant" or "electrical" alloys for the reason that they did not oxidize or scale readily at high temperatures — 1200 to 2200°F. They

had excellent mechanical properties and strength at these temperatures and had, as well, high electrical resistance and low temperature coefficients thereof. A famous electric resistance element made from alloys containing nickel and chromium was patented by Albert L. Marsh in 1906. These alloys generally contained more than 50 per cent of nickel and less than 50 per cent of chromium and preferably more than 75 per cent of nickel and less than 25 per cent of chromium.

The commercial uses of the heat-resisting alloys were as varied as the industries that operate at high temperatures. One of the better-known uses was the carburizing box — that is, the container in which steel parts are case-hardened by being subjected to high temperatures in mixtures of charcoal, carbonates and other ingredients. In the chemical industry, large cylindrical retorts were employed at temperatures exceeding 2100°F.; operations became possible in many fields that previously had been impossible.

The same thing was true of ferronickel alloys where commercially new and useful compositions were coming into prominence. One of these was an alloy containing about 78.5 per cent nickel and about 21.5 per cent iron, trademarked Permalloy, and which was developed by the Western Electric Company for use in ocean cables as well as in telephone and radio communication. The engineering importance of the alloy for cable construction was illustrated by its performance. By its use the rate of cable communication was increased from 300 to 1,500 signals a minute.

Increasingly, engineers were recognizing the unique contribution of nickel to alloys of which it was a part — increase of strength at ordinary temperatures, ability to maintain its strength and resist oxidation at high temperatures, and resistance to corrosion — and were accepting it as the best metal with which to start.

Helping in creating markets where no markets existed was an advertising and sales program which was designed to enlist the co-operation of people in various branches of industry by stimulating them into finding new uses for nickel. The advertising part of the program was not begun without misgiving.

Years before, and in a burst of enthusiasm, the company had run a page advertisement in *The Saturday Evening Post*. The date was October 4, 1919. The advertised product was a Monel nickel-copper alloy. The company received a lot of letters from a lot of people who asked a lot of questions. In describing the properties and uses of Monel alloy, the company had failed to translate these properties and uses into products. In fact, the company had no products for public consumption. It was a profitable experience, although not so realized at the time. About all that could be done was to thank the letter writers for their interest.

This time before spending any money the company prepared the ground. It learned that the markets for the Monel alloy were in such fields as chemicals, power, textiles, laundry and food service. Turning over the information to an advertising agency, the company was advised to spend $23,000 — the entire appropriation — in trade papers. It was an unusual recommendation inasmuch as trade paper advertising was not then held in high esteem.

In spending the money, the agency used a basic case history approach and sought to help fabricators, who were

the customers, by bringing their names into the copy. In each advertisement was an illustration of a use for Monel nickel-copper alloy, such as the advertisement which carried a photograph of a battery of dye kettles in service. In the headline was this statement: "Those Monel Tanks Ought to Outlast the Building"; and eased into one corner of the headline was a small insert containing these particulars:

> All Monel [nickel-copper alloy] dye kettles in Textile Dye Works, Philadelphia, Pa. Kettles are solid metal of welded construction. Manufactured and installed by Liberty Coppersmithing Co., of Philadelphia.

Much of the information about fabricators was obtained by salesmen. Calling on customers in search of information for use in the advertisements gave salesmen opportunities to become better acquainted with users of nickel, in addition to helping to solve market problems for these same customers, if asked.

Sales and advertising programs were worked out in the same manner as were the development and research programs — and often around the same table. In each case, management sat with the specialists. The purpose behind the meetings was to acquaint management with the views and problems of the experts, and the experts with the views and problems of management — and, of course, to arrive at decisions.

The meetings were held in an atmosphere where everybody was looked upon as a partner in the building of a business, and so imbued was everyone in building markets that in 1925, two years after the departments were formed and three years after the Huntington plant was activated, the annual consumption of Monel nickel-copper alloy was increased from 3,000 tons to 7,500 tons.

With two fellow executives, Stanley went to Europe in the spring of 1926. On the way across the Atlantic they talked a great deal about new markets, about new products, and about how to get closer to the people in the trade. In the course of the discussions there was developed the idea of establishing a number of bureaus, through which technical information on nickel and nickel products could be distributed. The theory was that if equipped with information, technical people, for themselves, would find new uses for the metal.

As is usual with an idea which arises from several people talking and thinking about the same problem, no one of the three was the originator. It just seemed to grow out of the consideration of a number of conditions.

The first was to do something to increase European nickel consumption. The second involved doing something which would make available to the consuming trade in Europe technical discoveries and advances made in any part of the world — and doing it on such a basis that no individual customer could claim that some competitor had been favored at his expense. The third was the feeling that no one in the nickel business in Europe had close enough contact with the trade.

Through the bureaus it was hoped to establish in the minds of people that they could get quick, technical information — and especially honest technical opinions. By so doing it also was hoped the company would build up a friendly relationship throughout the nickel-consuming industries. In the bureaus would be no salespeople, and no order books. Nothing would be sold. It would be strictly a service to industry.

The first Information Bureau was set up in Paris in May 1927. Joseph Dhavernas was in charge. It was the beginning of a service that has become world-wide.

In 1927, sales of nickel totaled 45,559,000 pounds, as compared with 12,804,000 pounds in 1922. Nevertheless, and in spite of the great increase in sales over five years, the company was not getting enough business to bring the Huntington plant to capacity. With his associates, Stanley reviewed the company's entire marketing program, and finally decided the one thing that was not being done that other companies were doing, marketwise, was national advertising.

Industrial advertising had grown from an expenditure of $23,000 to an expenditure of $130,000; but still remembered — unpleasantly by Stanley — was the page advertisement in *The Saturday Evening Post* in October 1919. It took more than a few words to break down his resistance, but finally, and more in acceptance of the argument of "touching all the bases" than from any convincing rebuttal, he gave his approval to the spending of an appropriation of $135,000 in *The Saturday Evening Post* and the *Literary Digest.*

Although it had no consumer products, the decision to use consumer publications did not affect the company's basic philosophy regarding advertising. It continued to think in terms of helping customers. It saw good reason why this market, which was made up of all sorts of people, should be informed about nickel, and its wide variety of uses in all kinds of products.

The first advertisement appeared in *The Saturday Evening Post* in its issue of November 5, 1927. Emphasizing where Monel nickel-copper alloy "shines," the copy identified several manufacturers who used the metal in their products and went on to suggest that readers remember that manufacturers use Monel alloy "to give you — the customer — better quality, and longer service in the equipment you buy. . . ."

In 1928, Inco's nickel sales totaled 76,303,000 pounds, as compared with a previous high of 71,354,000 pounds in 1918. Indispensable in war, nickel had become even more indispensable in peace.

In these years of the late nineteen-twenties, The International Nickel Company changed from a mining company to a company where production and the creation of a market were of equal importance.

Stanley and his Directors were unanimous in deciding the time had come to make the parent company a Canadian company.

On October 31, 1928, the long-considered step was taken. More than twelve years previously The International Nickel Company of Canada, Limited, had been incorporated under the Dominion Companies Act as a subsidiary company. That was on July 25, 1916. Now on October 31, 1928, and with the overwhelming approval of the stockholders, the two companies were changing places.

In recognition of (1) the fact that it owned more than 90% of the total properties held by it and its parent company; (2) the often-expressed wish of the people of Canada that the parent company be a Canadian company; and (3) the requests of many stockholders, The International Nickel Company of Canada, Limited, became the parent company and The International Nickel Company, Inc., became a subsidiary.

12

The Problem of the Frood Mine

FOLLOWING the death of his father, Ludwig Mond, on December 11, 1909, Alfred Mond, now Chairman, visited the company's Canadian properties. Accompanied by his brother Robert Mond, and Dr. Bernard Mohr, Alfred Mond inspected the new hydroelectric plant on the Vermilion River, ten or twelve miles from the Victoria mine.

Thinking in terms of growth, Mond authorized C. V. Corless, general manager of the Canadian operations, to build a new smelter at Coniston to take care of the output of the Garson mine. Starting operations in 1908, the Garson mine had become the company's principal source of supply. At the same time, Mond became interested in two of his company's other properties. One property was in Levack township, twenty-odd miles north and west of

Sudbury; the other property was in McKim township, a few miles north of Sudbury.

Located on the northern rim of the Sudbury hills, the Levack deposit was discovered in 1888 by two Indians employed by Rinaldo McConnell. On October 30, 1889, McConnell obtained a patent. On November 4, 1889, James Stobie received a patent on a neighboring claim.

Actually, Stobie was first on the scene. Two years previously he was investigating rock cuttings and gravel pits and was on the verge of success when winter snows forced him out of the neighborhood. He did not resume his investigation until 1889. Mond bought the claims in 1913, opened the deposit in the same year and, in 1914 and 1915, took out 48,467 tons of ore.

But prior to the Levack purchase, Mond paid $100,080 for two small parcels of land in McKim township.

In July 1884, Thomas Frood, a wood ranger for the Crown Lands Department, and A. James Cockburn, a prospector, found evidence of copper along a creek in the northern part of McKim township. The two men staked adjoining claims. Cockburn staked the top of the hill; Frood staked an outcrop on the side of the hill. Cockburn sold his claim to J. H. Metcalf and W. B. McAllister; in turn, all three men sold to the Canadian Copper Company.

Identifying the Frood deposit as Mine 3 (now the Frood mine) the Canadian Copper Company opened the deposit in 1899. From 1900 to 1903, 110,545 tons of ore were lifted, after which the mine was closed. The ore was not rich enough in mineral content to offset the difficulties of working it. Mond knew of these difficulties but they did not deter him from paying $100,000 on January 22,

1910, for one parcel (known as North East ¼ Lot 7, Con. VI, McKim). The seller was Frank Cochrane to whom title had passed on March 26, 1908.

The second parcel (known as North West ¼ Lot 7, Con. VI, McKim), which became unpatented along about 1909, was staked as a mining claim to which Mond received final patent rights on August 30, 1911. For these rights, Mond paid the established government fee of eighty dollars. Ironically, the second parcel proved to be more valuable; singularly, in buying the two parcels, Mond determined the future of his own company.

In 1916, Mond began drilling what was called the Frood Extension. Borings reached a depth of 1,005 feet, and were stopped. The Levack ore was easier to mine, easier to work, and nickel was in sharp demand. With the outbreak of World War I, the Canadian Copper Company reopened its holdings, lifted 174,350 tons of ore in 1913, 1914 and 1915, and again suspended operations. In the five years of operations (1900–03, 1913–15) the total production was about 280,000 tons. It was a total production which showed average contents of 2.15 per cent nickel, and 2.22 per cent copper.

The management of Inco did not know, nor did Mond, that, despite its complexity, they were dealing with one of the great nickel-copper deposits of the world. But they did suspect it.

As a witness before the Royal Nickel Commission on December 22, 1916, A. D. Miles, President of the Canadian Copper Company, was asked:

"If you had a mass of ore in the ground that contained three per cent metallic contents, would you regard that as worth anything?"

"Oh, yes."

"Well then, in what case would ore containing not more than three per cent not be valuable?"

"If you take a deposit such as the Frood, the mineral is scattered through it in such a way that it would have to be separated mechanically, and it does not readily lend itself to hand picking. In other words, the ore is mixed with rock throughout, but as all the rock is mineralized, it is very difficult to separate by hand."

"Take the Frood ore, if the Frood deposit had been less than three per cent would you have regarded it as a valuable mine?"

"Yes, I would," answered Miles, "but I would not as the mines are worked now . . ."

"Would that opinion be based upon the fact that the ore is not easily workable; you do not want to be bothered with it, you mean?"

"Yes. It will not be necessary to work those ores for a good many years to come, but I daresay by the time we are ready to work them, methods will have been developed which will enable us to work them at the same cost."

Testifying before the same commission, C. V. Corless referred to the different mining operations in the Sudbury district and identified the Frood as "the mine having the greatest promise [although] it is not now being worked."

"That is what you call the Frood Extension?"

"Yes."

He said that diamond drilling had indicated a deposit of about 500,000 tons of ore containing 2 per cent nickel and an equal amount of copper, and explained that because of hostilities in Europe, development work was concentrated on the Levack mine where the ore was easier to work.

Before World War I, and to implement its program

of expansion, The Mond Nickel Company completed arrangements and obtained the money needed for the purchase of the Levack mine and the building of the smelter at Coniston. In 1914 there was a capital reorganization. The issued capital of the company became approximately $12,000,000 which was double the previous amount. The date of reorganization was July 22, 1914. Less than two weeks later, the United Kingdom was at war.

With its expanded resources, Mond was better prepared for the heavy demands made upon it, but not well enough prepared. To step up mining operations, to increase the capacity of its smelters, to double the output of its refineries and to triple the size of its labor force required substantial borrowings from banks in England and in Canada, and the issuance of redeemable debenture stock.

With the war ended, and old markets gone, Mond was attracted to the increasing civilian demand for kitchen utensils and mill products. Realizing its own lack of experience in this field, it initiated conversations with Henry Wiggin & Company, Limited, in Birmingham. Long experienced in the production of nickel alloys, Wiggin ended the war with little business and less money. In acquiring all the Wiggin stock, Mond kept the entire Wiggin staff "to provide," as A. C. Sturney wrote in his *Story of Mond Nickel,* "the skill and experience needed for the running of the milling operations."

Satisfied that the production of nickel alloys was in good hands, Mond turned its attention to the task of recovering an even higher percentage of the platinum and other precious metals in the Sudbury ores. A pilot plant was set up in southeast London with Dr. Bernard Mohr in charge.

In 1908, when employed by the Allis-Chalmers Company of Milwaukee, Wisconsin, Grant B. Shipley, an engineer, was sent to Sudbury where he met Alfred, Robert and their cousin, Emile Mond, who were visiting the Victoria mine. The Monds were considering the purchase of new equipment. Shipley's suggestions were so helpful that when he left he had a signed order for the equipment. It was the beginning of a lifelong friendship with the Monds.

One day in the spring of 1921, Shipley was in his office in Pittsburgh, talking with W. T. Dethloff, a draughtsman formerly in Shipley's employ. After explaining that he was on a mission the nature of which he could not disclose, Dethloff said he was "in need of a dependable lawyer" — and asked, "Can you recommend such a man?" Shipley gave him the names of three attorneys. One was employed.

Two months later, Dethloff, by then openly employed by Mond, again was in Shipley's office. This time he was accompanied by C. V. Corless who, after telling Shipley of plans by the Mond company to take over the assets of the Nickel Alloys Company, Inc., in Clearfield, Pennsylvania, and form a new company, delivered a message:

"Sir Alfred Mond has asked me to ask you to be a director in the new company."

It was a pleasant invitation, and one Shipley was happy to accept.

A short time after being named a director, Shipley attended the organization meeting of the American Nickel Corporation. George P. Bassett and Charles T. Hennig, officers in the old company, were continued in office, Bas-

sett as President and Hennig as Vice President. Dethloff was named Vice President and Chief Executive Officer. Almost at once directors' meetings were being held in a sharp-tongued atmosphere.

But Shipley found the plant to be old and the equipment obsolete. Shipley's criticisms soon reached the ears of the Monds. They bought out the Bassett and Hennig interests, changed the company name to American Mond Nickel Company, and placed Dethloff in charge.

In Clearfield, Pennsylvania, in June 1927, American Mond Nickel Company was having a struggle to make a little money and Grant Shipley, who had succeeded Dethloff in managing the subsidiary, was in London. While there he was notified of his election to the Board of Directors of the parent company, in addition to his appointment as Chairman of the Executive Committee in Canada.

Back in Clearfield, Shipley thought a good deal about his new responsibilities. As soon as he could, he went to Sudbury not only to look in on the Mond properties, but to call on Inco officials who were friends from the days when he sold them Allis-Chalmers equipment, that he might, as he said, "learn about the nickel business from mine to consumer." He asked a lot of questions, confirmed information that had come to him as rumor, and heard some very important things.

He knew that, in 1924, engineers had predicted the early exhaustion of the Creighton mine and that, to offset the anticipated losses, Inco was conducting an extensive construction and development program at the Frood deposit.

It was a program that included the building of a power station at Big Eddy on the Spanish River, the construction of a gravity section concrete dam at Ramsey Lake to conserve water, the building of all sorts of facilities including a cage hoist with a capacity of raising, or lowering, sixty men.

In 1928, when Shipley again was in Sudbury, the work at Inco had progressed substantially. While exact tonnages or average metal contents in the lower levels of the ore body could not be determined, a five-compartment shaft had been sunk to a depth of 3,040 feet. Further, the crosscuts that had been driven in the lower levels disclosed reserves of high-grade ore in sufficient tonnage to run the smelters for many years.

On the 1,200-foot level, crosscuts showed channel samples containing copper 1.77%, nickel 2.61% and rock 5%; at 1,600 feet, copper 2.90%, nickel 2.15% and rock 9.3%; at 2,000 feet, copper 2.09%, nickel 1.93% and rock 5.9%; at 2,400 feet, copper 3.6%, nickel 1.5% and rock 28%; at 2,800 feet, copper 12.14%, nickel 2.66% and rock 19.2%. At the end of 1928, approximately $10,300,000 had been spent on the program. It was estimated that an additional $14,000,000 would be needed to complete it.

It was construction and development work that had not gone unnoticed in the offices of the Mond Company in London. In 1925, and after a lapse of nine years, Mond resumed drilling operations on its own part of the Frood deposit. By 1928, a four-compartment shaft had been sunk to a depth of 3,345 feet, with levels having been established at 400, 750, 900, 1,200, 1,400, 1,700, 2,000, 2,400, 2,800 and 3,300 feet.

In addition to the percentages of copper and nickel in the crosscut samples of Inco ore, Shipley was advised on other matters. He was told that the Nickel Company

was planning to build an electrolytic refinery at Copper Cliff to produce electrolytic copper, rather than blister copper, by drawing on the Frood ore as a source of copper and supplementing with ores from Creighton and other mines to produce the needed nickel.

Informed that Inco was planning to spend $25,000,000, and more, on Frood improvements which included the building of a new concentrating and smelting plant, Shipley hired two engineers, one a concentration engineer, the other a smelting engineer, to help him work out lower matte costs and to that end to lay out a more efficient flow sheet. With this work started, Shipley gave his attention to the job of estimating how much money Mond would have to spend in making the necessary changes in its mining and smelting methods.

Preliminary figures indicated an expenditure of $12,000,000. Checking the estimated cost against the fact that the Frood deposit was jointly owned, Shipley came to the conclusion that what was needed, if the mine were to be properly developed and all the ore recovered, was single ownership and not a duplication of effort.

After long analysis, and long thought, Shipley went to London in June 1928. By arrangement he met with Sir Alfred Mond and the Directors of The Mond Nickel Company. It was a meeting in which Shipley carefully produced comparisons showing how, by consolidating their efforts in developing the Frood mine, the two companies could conserve ore, reduce costs by approximately 19 per cent and, at the same time, save very large sums for capital expenditures and equipment.

"What do you think we should do?" inquired Sir Alfred Mond.

"I think you should see Stanley."

"And then?"

"I am sure you two men could work out an arrangement that would be satisfactory to all concerned."

Interested but noncommittal, Mond, who on that same day was elevated to the peerage and became Lord Melchett, asked: "What are your plans for the next few days?"

"I was thinking about going to Germany for a week. Then I was planning on coming back to London for a day or two, before returning to America."

"While you are gone I will look over your figures again, and see what I can develop."

When Shipley returned to London, Melchett told him: "I will be on your side of the Atlantic in September. At that time I will call on Stanley."

Lord Melchett did as he said he would do. He went to Canada in September, had guarded talks with a number of his stockholders, and then went to see Stanley.

Stanley knew a great deal about the Frood deposit. Inco had explored the ore body and, by 1922, had proved the presence of more than 90,000,000 tons. Early in 1926, a year after Mond had resumed drilling operations on its own side of the deposit, Inco employed an independent group of mining engineers "to study and counsel with the company on the many problems involved in the development of the mine."

On June 14, 1926, the engineering firm made its report, and in the report cautioned:

> The ore developed by the Mond Company, operating to the northeast of the Frood, is coextensive with that of the International Nickel Company. . . . We are not advised as to the scale of operations,

> actual or anticipated, but unquestionably there will be damage caused by ground subsidence which may result in serious controversy. Presumably, Provincial statutes prescribe regulatory procedure, but mutual understanding and goodwill between neighboring companies as to what extent the rights of ownership shall be respected to insure the greatest tonnage to respective parties is highly desirable before physical damage occurs. . . .

The Frood orebody was adjacent to the Stobie deposit, with which it was subsequently connected in a single mining operation. The Frood-Stobie deposit was an irregular lenticular body elongated in a northeast-southwest direction and inclined at 75° to the northwest. It had a maximum length of about 9,500 feet. The length lessened somewhat with increasing depth, and the deposit bottomed by wedging out at about 1,200 feet below surface in the central section and at about 3,800 feet below surface at the northeast and southwest extremities.

It was an ore body in which ownership overlapped. In relation to Inco holdings, the surface exposure of mineralization on the Mond property was small (only about 700,000 tons) the inclination of the ore body being such that a progressively large percentage of ore occurred on the Mond property as the depth below surface increased. Below the 1,000-foot horizon (approximately) Inco's ore body was separated into two entities by the intervening Mond parcel. If for no other reason, and there were other reasons, these two circumstances were insurmountable barriers to the full development of the property.

Access to the Inco workings was provided by a shaft located in the footwall of the ore body, while the Mond workings were serviced by a hanging wall shaft which passed through the ore body between the 1,150- and 1,450-foot horizons. These things Stanley knew, just as he knew Mond had started development on 1,400-, 1,700-, 2,000-, 2,800-, and 3,100-foot levels, had opened up some stopes on 2,800- and 3,100-foot levels, had sunk a shaft to a depth of 3,345 feet, and had a small surface plant, including ore crushing and loading facilities.

The Mond plant was adjacent to the shaft and was serviced by a road, as well as a railroad, which passed over Inco's part of the ore body. Another complication was the fact that the higher-grade ore was located in the lower levels. Consequently, if separate operations were conducted, mining probably would have been confined to the lower levels and carried out by fill methods by both companies.

During this stage there would have been many problems. Based on the estimated capacity of its shaft, Mond had enough ore below the 1,800-foot horizon to last about forty years, at which time it would have been necessary for it to relocate its shaft and surface plant. However, if in the forty years Mond found it necessary to increase its productive capacity, a new shaft and plant would have been required at an earlier date. If so, Mond would have had no alternative but to make an arrangement for a location of both its shaft and its surface plant on Inco property.

Assuming that ground conditions would have required mining by fill methods below, as well as above, the 1,200-foot level, a maximum boundary pillar of about 200 feet

in width* would have been a necessity between the surface and the bottom of the mine. All by itself, this pillar would have tied up some 10,000,000 tons of ore.

In terms of mining by open-pit methods, the Mond property infringed on the widest section where such methods were most favorable. Protection would have been needed to keep the Mond holdings from possible movement toward, or collapse into, the pit. This protection would have been in the form of a surface pillar surrounding the Mond property, as well as pit slopes from the edge of the surface pillar to the bottom of the pit. This meant tying up additional millions of tons of ore.

By December 1928 each man had reached the same solution for the problem of the Frood mine. The solution was single ownership.

It was obvious to Melchett, even before Shipley brought the matter sharply to his attention, that the installation of two complete sets of equipment for the mining of one body of ore would be extravagantly wasteful.

For Stanley, who recognized the same extravagance, it also was a solution that ensured the future of his company. The Frood was a deposit of dimensions. The outlook at Creighton, Inco's principal source of ore, was uncertain. Engineers were saying the mine was becoming exhausted. Within arm's reach of his desk were reports which said:

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*The assumptions made in arriving at the estimate of 200 feet are predicated on a large degree of cooperation between the companies. At the time, the Ontario Mining Act established 7½ feet as the width of boundary pillars on both sides of the boundary lines. This was based on the requirements of the narrow-vein gold mines. Such a boundary pillar would have been wholly inadequate in the Frood ore body.

1856 — Creighton deposit discovered by A. P. Salter and Alexander Murray.

1886 — Deposit rediscovered by Henry Ranger.

1900 — First mined by open pit method, going down 300 feet.

1911 — Ore body is funnel-shaped, and pinches out. Walls coming together at sixth level. Running out of ore. Looks like end of mine.

1915 — Underground diamond drilling, along with mining operations, showed that ore body extended at least 1,300 feet. Ore body bottomed out at 1,650 feet.

1920 — New ore body found.

1926 — New ore body found.

1928 — Recovering bits of pillar along with odds and ends from upper levels. Running short of ore.

Melchett, of course, did not know the details of what was threatened; nor, for his part, did Stanley know that soon Creighton would reclaim its legacy — that, in 1930, the *Engineering and Mining Journal* would be saying, "Creighton is still a fine mine with a long future"; and, in 1959, it would be pointed out that "mining at Creighton has now continued for 60 years, and it will take many more years of mining to deplete the ore body. The success of the panel caving method has meant a complete rejuvenation of this great mine."

Stanley was sure, and so was Melchett, that with amalgamation it would be possible to have one system of development covering the entire mine. Each man recognized that separate "development" of the ore body would be inexcusably wasteful of one of the national resources of Canada; that the sound development of

Canadian nickel resources was necessary to the sound development of Canada's economy; and, to avoid wasteful and costly results, it was appropriate that The International Nickel Company of Canada, Limited, should acquire The Mond Nickel Company, Limited.

There were many discussions and finally an agreement. It was an agreement under which, through an exchange of stock, there would be a fusion of interests. On December 18, 1928, Melchett wrote a personal letter to Mond shareholders in which he said, in part:

> . . . I have personally been convinced for some time of the desirability of a fusion of the interests of your Company and The International Nickel Company of Canada, Limited. During my recent visit to Canada I had the opportunity of inspecting the properties of both companies and of going fully into the position, and I am satisfied that far-reaching economies could be achieved by such a fusion.
>
> With regard to the Frood mine which contains an enormous tonnage of unusually rich copper-nickel ore, part of which is owned by your Company but the major part by the Canadian Company, I am satisfied that it will be developed to the best advantage by mutual cooperation and by pooling the financial resources of the two companies.
>
> I am myself the largest individual Shareholder in the Company, and with other members of my family constitute a group of the largest Shareholders. We have no hesitation in accepting the offer to exchange our shares for those in The International Nickel Company of Canada, Limited, convinced as we are, after an exhaustive examination of all aspects of the

situation, that the terms offered are fair and reasonable in every respect. . . .

During the last few years I have myself been concerned with several important reorganizations affecting British and Imperial Industry, and I have never known a case where fusion of interests was more desirable or more likely to have beneficial results for all parties concerned than the one which is now proposed. . . .

The principal Mond properties to be acquired by The International Nickel Company of Canada, Limited, included the Frood Extension, the Garson and Levack mines, the smelter at Coniston, a nickel refinery in Clydach, Wales, a precious metal (silver, gold and platinum metals) refinery at Acton, London; and Henry Wiggin & Company, Limited, operating rolling mills, fabricating and chemical plants in Birmingham.

As of January 1, 1929, the two companies became one enterprise. The judgment of Stanley and Melchett in working the ore body as a unified operation was proved to be right, many times over.

Had dual operations existed, the amount of ore mined by low-cost, open-pit methods would have been about 30,000,000 tons. Under single ownership more than 70,000,000 tons of ore have been mined by open-pit methods.

As was pointed out, the Mond property infringed on the widest section of the pit where it was possible to mine to the greatest depth. The factors of infringement on the pit, and the building of protective measures to keep the Mond property from shifting toward, or collapsing into,

that same pit, would have limited open-pit mining methods to about 260 feet below surface.

Approximately 6,000,000 tons of potential pit ore would have been tied up in the protective pillar and by the relatively flat slopes. With the elimination of the boundary problem, an ultimate open-pit depth of 600 feet was reached. Between 260 feet and 600 feet below surface, about 24,000,000 tons of ore were mined. In addition, between the 1,000-foot level and the pit bottom, it has been possible to mine more than 11,000,000 tons of ore by another low-cost method, the blasthole method.

Numerous fields of duplication in facilities were eliminated, facilities such as: drifts providing access to the ore body, underground service equipment, underground crushing and ore pass systems, mine ventilation, mine water supply, mine fill system, drainage and pumping systems, hoisting facilities, surface mine plants, rail and road facilities, hydroelectric power distribution systems, compressed air and water distribution, refuge stations, underground warehouses, magazines for explosives — all sorts of facilities.

Besides unlocking millions of tons of ore and avoiding duplication of facilities, the amalgamation greatly reduced the danger of underground fire by doing away with the need for major separating pillars on the high-grade lower levels. This particular ore has a relatively high (16:1) pyrrhotite to nickel ratio, and is susceptible to rapid oxidation when broken. As mining progressed and subsidence and ground pressure developed, crushing would have developed in the boundary pillar. The rate of oxidation would have been increased in proportion to the degree of crushing and could have reached the open combustion stage.

Rock bursts caused by pressure on the lower levels of the ore body would have become an even more serious problem. Since its opening, more than one thousand rock bursts and tremors, supposedly associated with unlocated rock bursts, have been recorded at Frood. To control the frequency and severity of the rock bursts, suitable mining sequences have been devised to cover the entire ore body; also, stopes and pillars have been standardized to the most favorable sizes in order to further alleviate the problem. The mining sequences and standardization of stope and pillar sizes give a gradual and continuous redistribution of stresses around the mine openings.

As mining progressed after the amalgamation and absolute support was removed from the hanging wall, it was necessary for the unsupported portion of the hanging wall to find its support in the virgin areas adjacent to the active mining area. In a large ore body like the Frood, much transfer and redistribution of stress occurs while this is being accomplished. With dual operations, the job of establishing and maintaining satisfactory mining sequences would have been difficult, if not impossible, even with close cooperation between the two companies. The rate of mining in each area would have been dictated by factors other than proper mining.

Moreover, the mining sequences would have lost much of their effectiveness when broken by a major pillar separating the properties. Further, as more and more support was removed from the hanging wall, the separating pillar would have been subjected to increasing loads. This loading could have reached such proportions that the pillar would have failed violently in the form of major rock bursts with the allied hazards to the lives of people on both properties.

Subsidence and ground control became problems of high importance as mining progressed and support was removed from the hanging wall. Control was exercised in early years by the use of rock fill in stopes and pillars and in later years by water-borne sand fill prepared from mill tailings. In the early years when rock fill was used, subsidence and ground pressure were serious.

Had Mond or Inco mined in an area prior to the other, even with a 200-foot separating boundary pillar, some effects of this subsidence and ground pressure would have been transferred to the other company's area. One certain result would have been poorer mining conditions for both; another result could have been tragedy.

Although larger than either man could have dreamed, the savings Stanley and Melchett were sure would come from single ownership did come. Stanley and Melchett each understood that a nation's wealth, whether in the form of soil, forest or minerals, is a heritage – and that the greatest assault upon this heritage is waste; for it is the waster whose sense of values is so dull that he does not perceive that in soil is food, in forest is shelter, and in minerals is progress.

It is unlikely either man thought of a nation's resources in those particular terms, but each was aware of them, and did speak of them as a heritage and not as something to be dissipated. That is why in each was an abhorrence of waste. Under single ownership Stanley was able to begin the fullest development of one of the world's greatest ore bodies and to avoid stupendous waste.

Represented in their achievements is a stronger national economy, the result of the conservation of a nation's resources, new uses for nickel, widened markets, greater and more stabilized employment, higher wages, and a company better able to carry its first responsibility, that responsibility being to strengthen the economic life of the nation.

As a result of the merger, Inco was able to report "proven ore reserves [totaling] 202,620,000 short tons. This tonnage includes: Frood Mine, low grade, 91,111,000 tons, Frood, high grade, 43,562,000 tons; Creighton Mine 5,503,000 tons, Levack Mine 19,062,000 tons, Garson Mine 3,193,000 tons, Murray Mine 22,490,000 tons, Stobie Mine 13,712,000 tons, Crean Hill Mine 3,028,000 tons, other mines 959,000 tons."*

Within a decade they were ore reserves that would serve as a vital defense material in protecting Britain and Canada, the United States and other nations from armed forces that were moving with speed and with power.

*Annual Report 1929, The International Nickel Company of Canada, Limited.

13

The Nineteen-Thirties

While one or two decades do not make a good unit by which to judge history, the 1930's did contain certain important developments in the history of the nickel industry, just as the 1920's marked a change of attitude in which distribution and the creation of markets assumed equal importance with mining and manufacturing.

In the International Nickel Company changes, both internal and external, were very great. In 1929, International Nickel and Mond became one company.

In a way this consolidation was like the dynastic marriages which in the past so influenced the course of European history. The mines, plants, mills and other physical properties were united under a common head. With that done, there remained the task of what might be called emotional consolidation, when the personnel of three companies, Canadian, British and American, fused into a working whole. . . .

And where, from the reactions of various experiences and histories, there could be developed a basic common policy to which all could give not only intellectual agreement — but, in addition, that emotional acceptance and support which is so essential if people of different racial and geographical backgrounds are to perform together in a constructive manner.

Considering first the internal changes which necessarily focus upon certain individuals: From 1902 until 1931, the organization of International Nickel had been of the simplest kind. The company had a president, one vice president, and a third ranking officer who was called assistant to the president.

In 1931, J. L. Agnew, Vice President, died and I became his successor, being moved up from my job as Assistant to the President. Born in the United States, Agnew went to Copper Cliff in his youth and by sheer ability had risen from the bottom to the top of the Canadian company.

He was a man of great driving power, accompanied by vision. In his period of direction of Canadian affairs, the value of the Frood mine was discovered, the mine opened and a new metallurgy established involving a complete rebuilding, on a different basis, of all the Canadian operations. Realizing the part modern geology should play in the affairs of a mining company, Agnew originated and set up the Geological Department which, while first working on the geology of our Sudbury ores, was (in the 1950's) to discover the Manitoba deposits.

In the same decade, Canadian process research was put on a more organized basis through the intro-

duction into the organization of J. Roy Gordon, later to become General Manager of all Canadian operations, Vice President, Executive Vice President and, in 1960, President of the company. Born in Ontario, Gordon was educated at Queen's University, Kingston, Ontario, as a chemist. Following graduation he was a research man for the Deloro interests of M. J. O'Brien and the Ontario Research Foundation in Toronto until, in 1936, he became Director of Research at Copper Cliff.

Coming with the company, likewise in the 1930's, was Henry S. Wingate. Born in Turkey of American missionary parents, and a graduate of Carleton College, Minnesota, and of the Law School of the University of Michigan, Wingate came to the company in 1935 from the New York law firm of Sullivan & Cromwell, Inco's legal counsel in the United States, and thus began a career in the nickel industry which has led him to the presidency in 1954 and the chairmanship of the company in 1960.

Before the coming of Wingate and Gordon, it became evident, with the consolidation of International Nickel and Mond, that the previously scanty organization would have to be expanded so the company would have a responsible officer in each country, with a title commensurate with his position. As a result, on March 2, 1936, a formal reorganization took place whereby D. O. Evans (United Kingdom), D. MacAskill (Canada) and P. D. Merica (United States) became Vice Presidents, and I became Executive Vice President.

David Owen Evans, a Welsh barrister and later a member of Parliament, had previously been Secreary of Mond. He died in 1945 just after the honor of Knighthood had been announced and was succeeded as Chairman by Dr., later Sir William Griffiths, who had previously been Director of Research. In that office he had been in charge of the work carried out in the Birmingham Research Laboratory by Dr. L. B. Pfeil and his colleagues which led to the invention of the Nimonic high temperature alloys.

Succeeding Griffiths as Chairman of Mond was Lance H. Cooper, previously Secretary; George Archer who at the time held high office in the Ministry of Supply; and Ivon A. Bailey, for a long period in charge of the company's production at Clydach and Birmingham. During this period, the others carrying managing directorship responsibilities were L. K. Brindley and John O. Hitchcock.

Donald MacAskill was a Scot who began as a smelter's helper at Copper Cliff in the early days of the Nickel Company. He shifted into a clerical job, but went back to the smelter where, after a few years, he became assistant superintendent, then superintendent. Following Agnew's death in 1931, he became General Manager of the Canadian operations and later Vice President.

In January 1943, MacAskill died and was succeeded by R. Leslie Beattie who, like his immediate predecessor, fitted himself for promotion through early clerical work at Copper Cliff. Although not technically trained, Beattie was able to deal with the complexities of mining and smelting and marketing because of his understanding of people, his own common sense and his great interest in everything pertaining to the nickel business.

While Paul D. Merica came with the company in 1919 as a top-grade scientist, which made him an ideal director of research, he also possessed a strong commercial sense which made him a very effective

negotiator and executive. On May 5, 1952, he became President while, in 1939, James L. Ashley who had been Secretary and Treasurer of the company since its formation in 1902, retired and was succeeded as Secretary by Henry S. Wingate and, as Treasurer, by William J. Hutchinson.

Externally, the company also went through a very interesting period. Having started in 1921 to build a market for nickel, this work came to a temporary climax in 1929 when more nickel was sold for peacetime purposes than had ever been sold before in any single year, including wartime peaks.

Following the stock market crash and the general collapse of business in the latter half of 1929, the world's nickel business shrank to a point where, in 1932, the world consumed only 57 million pounds of nickel. Of this amount, 34 million pounds were sold by The International Nickel Company of Canada, Limited, of which the United States consumed only 18 million pounds.

Naturally this resulted in very radical changes in the operation of the company, including some substantial salary reductions. But, although this period was disturbing to all of us personally, it never diverted us from the main objective of increasing the world's consumption of nickel. This work was carried on with full vigor, with the result that in 1935 sales again made a new peak, passing that established in 1929.

During these years many things were accomplished in the consolidation of the various operations which, being more internal and emotional in nature than having physical form, created no especially recordable history, but left the company an integrated whole when the war broke out in Europe in 1939. This was the period when the often-used phrase, "the nickel family," had its beginning as the result of a unity derived from a common objective when men of various nationalities, languages and religions could work together in common friendship.

Then in 1939 came the war bringing with it a complete change in direction and emphasis and leading to the war years when men who had spent their lives developing increased uses for nickel devoted all their time and energies to reducing and eliminating the uses of nickel for peacetime purposes — thus spreading, as far as possible, the quantity available for wartime applications.

Once again, as had happened in World War I, mine development was reduced and the full energy of the company was devoted to maximum production regardless of the future and regardless of cost.

j. f. t.

THE nineteen-thirties were years of depression and dissension throughout the world; also, they were years of progress for many companies, including Inco as well as Falconbridge Nickel Mines Limited. Organized in 1928, the new company's initial energies were directed at bringing into production a nickel-copper deposit in Falconbridge township. This was a deposit that, originally, was staked in 1901 by Thomas A. Edison but allowed, by him, to revert to the Crown in 1915.

Progressively, after this property was brought into production, the company extended its operations to other areas in the Sudbury Basin. As a result, it has become one of the world's major nickel producers. Meanwhile, in the nineteen-thirties, among many developments at Inco was an alloy marketed under the trademark "K" Monel.

On November 24, 1919, a memorandum was placed

on Merica's desk suggesting the development of "a stronger alloy than Monel [nickel-copper alloy] for steam turbine blading," and, in so suggesting, requested "that the new alloy have same resistance to steam erosion and corrosion . . . but have superior hardness and tensile strength."

Engineers knew that the higher the pressure of steam and the higher the temperature, the greater is the efficiency of the turbine. They also knew that, in order to utilize these higher temperatures, it was necessary to find a metal or alloy which could withstand the rugged operating service conditions involved. The strength of the Monel alloy could be increased by cold working but this was not enough. Clearly Inco had to find another way.

A small amount of aluminum-containing nickel-copper alloy was rolled at the Atha works of the Crucible Steel Company in 1921 for the General Electric Company. Later in 1921, Merica reported that a new Monel nickel-copper alloy, containing 4 per cent aluminum, had a very poor ductility in the temperature range of 1100° Fahrenheit. Nevertheless it was promising.

In December 1922, more than a year after the metal was rolled for General Electric by the Crucible Steel Company, Merica yielded to the insistent demands of General Electric that it be supplied with 10,000 pounds of the new alloy. The company agreed to begin shipments, and accepted the order. Eleven months passed. The order remained unfilled because Huntington was not satisfied with the development of the alloy. By mail, Huntington was asked: "Do you wish to cancel?" The reply was immediate: "No." The experiments continued.

Under a microscope one of the plant metallurgists found what he thought was an eutectic structure. In unscientific language, eutectic refers to an alloy whose melting point is below the melting of any other alloy made up of the same elements.

Thinking that under his microscope was evidence that the alloy was not the solid solution science said it was, the metallurgist reached for a duplicate sample.

Heating the duplicate sample to a temperature of 1600° Fahrenheit, he quenched it and overnight reheated it to a temperature of 1100° Fahrenheit. After aging overnight at this temperature the sample had hardened from Brinell 150 to Brinell 275. Thus the first age-hardening, wrought nickel-rich alloy was discovered.

With this information before him, the metallurgist went looking for the eutectic structure. He looked, and looked some more, but found nothing. Mystified, he returned to his first specimen, and learned that his eutectic structure was due to particles of dirt dried from his etching solution.

On April 3, 1924, Huntington supplied laboratory data defining, in detail, the temperature ranges and times at which age hardening occurred in the aluminum-bearing nickel-copper alloy; and in May 1924, seventeen months after General Electric had placed its order, Inco had 813 pounds of flats ready for shipment. The balance, or 9,187 pounds, was shipped soon afterward. Huntington was instructed to place 30,000 pounds in stock. In September 1924, the trademark "K" Monel was assigned to the alloy.

The trademark had scarcely been selected when General Electric notified the company that cracks and checks had appeared in the material. The shipments were recalled; sales were withdrawn; and the experts went back to work. A metal or alloy might be produced in a laboratory or even in a plant and look satisfactory, but still

not be capable of being fabricated into articles of manufacture.

Perceiving that certain nickel alloys could be substantially hardened by heat treatment, the experts converged on that field. The going was slow, but there was progress. Late in 1930, the beneficial effects of quenching the new alloy after hot working were becoming more and more apparent. However, the difficulty was largely associated with the behavior of carbon in the alloy. This element was useful in increasing strength but tended to precipitate in an undesirable way. This problem was corrected and the malleability of the alloy was vastly improved by the invention in 1932 of replacing part of the aluminum by titanium. This pair of metals later became important in producing high-strength jet alloys when added to a nickel chromium base. In January 1933, the first commercial heat of the modified "K" Monel alloy (nickel-copper plus aluminum plus titanium) was rolled. It was an alloy of exceptional quality.

Started in 1908, and worked on steadily since 1919, the long, hard effort was ended; and partly as a result of lessons learned, there followed, rapidly, extensive improvements in existing alloys and the development of many new alloys — within forty years, more than fifty.

The metallurgy of age-hardening high-nickel alloys led to a number of different alloys marketed under such trademarks as Duranickel, Permanickel, Ni-Span-C, Inconel "X," and especially Nimonic. For its age-hardening characteristics, each alloy relies upon the addition of one or more hardening elements to a nickel alloy.

It was industrial progress that came, as it always does, in return for thought, study, disappointment, work and money. Important, of course, were the special skills of the technical staff; but by no means were these special skills confined to the technicians. Sharing in them were the production men, the melters, forgers, rollers, and all the rest.

These were the particular years when Huntington men gained their great skills in the art of processing new and difficult alloys. New services based on new knowledge came into almost daily use.

The last years of the nineteen-twenties and the first years of the nineteen-thirties was a period of high importance in the progress of nickel metallurgy. They were the development years of nickel alloys; also, they were the years of acceptance of these same alloys, and of their application by industry.

It was a development that came as the result of recognition by workers in metals, and by designers in industry, that an almost limitless variety of alloys could be "custom-built" to meet the specific requirements of a given application. Using these alloys designers and engineers were able to do things with metals that previously were believed impossible.

By 1958, Huntington activities had become so important that it was decided to establish a separate division of the company, known as the Huntington Alloy Products Division. All the operating, sales, service and development functions affecting Huntington products were concentrated in this division and John A. Marsh,* who came with the company as a metallurgist in 1928, was named its first president in 1960.

In the automobile industry engineers were able to

*John A. Marsh is the son of Albert L. Marsh, who in 1906 patented the famous electric resistance element made from alloys containing nickel and chromium.

improve performance and reliability; in railroads, steam locomotives were able to operate at higher pressures with no increases in weight or bulk; equipment was provided for the petroleum industry that operated in temperatures as high as 1500° F., and as low as 75° F. below zero; in airplanes, alloy steels contributed to the continued improvement in power-weight ratios.

The advance was on a wide front. Outlined in the following table are the market changes that took place in the years between 1926 and 1936. Not only do the percentages show the increases in the consumption of nickel by industry; but, in large measure, they reflect the advances in alloy metallurgy:

	1926	1936
1. Alloy steel used in motor cars, trucks and buses	36%	20%
2. Alloy steel, inclusive of stainless steel, used in railroad equipment, farm implements, general machinery and miscellaneous applications	1	15
3. Nickel-silver and nickel-copper alloys for a multitude of uses	18	18
4. Pure rolled nickel in the form of rods, strip, wire and tubes, used largely in the radio, in the chemical industries and for coinage	10	17
5. Nickel for plating and as undercoat in chromium plating	5	10
6. Monel nickel-copper alloys used for engineering purposes and for household equipment	20	9
7. Alloy cast iron — castings of all kinds	1	4

8. Heat-resistant and electrical alloys ..	5	3
9. Miscellaneous uses including magnetic alloys, nickel brasses, nickel bronzes, nickel-aluminum alloys and white gold	4	4
	100%	100%

Taking the nine groups as a whole, one market accounted for more than one-third of the total nickel consumption in 1926, and three markets took 74 per cent of the total consumption; in 1936, the highest single market accounted for one-fifth, and the four highest took 70 per cent of the total.

When broken down, the foregoing table reveals a great deal about what was going on in the nickel business in 1936, and how markets had widened in the years that separated 1936 from 1926.

In use in the automobile industry in the United States and Canada in 1936 were seventy-nine alloy steels, of which forty-one contained nickel, as compared with a total of forty-eight alloy steels in use in the same industry in 1926 of which twenty-eight contained nickel. Included in the seventy-nine alloy steels in 1936 were ten nickel steels, twenty-two nickel-chromium steels, two nickel-chromium-molybdenum, five nickel-molybdenum and two heat- and corrosion-resisting steels of the austenitic type.

The large increase in the use of alloy steel in markets outside the automobile industry was due, in substantial measure, to advances in the technique of making these nickel ferrous alloys. Control of grain size and of other operating variables had progressed to the point where the quality of the steel base was so improved that smaller

percentages of alloy produced properties formerly available only in the more heavily alloyed grades.

By effecting important economies in production, this advance broadened the markets for alloy steels; at the same time, the field of usefulness of the higher alloyed steels had been extended proportionately, allowing engineers to keep pace with the increasingly severe requirements made on construction materials for heavy duty and high-speed service.

Intensive research and extensive field experience demonstrated that nickel steels in the as rolled or simple normalized condition would give excellent service.

This provided background for the development, during this period, of a new group of low alloy steels usually including nickel and copper, which had moderately high strength, improved resistance to atmospheric corrosion and good welding qualities. The particular advantages of these high strength, low alloy steels were relatively low cost, reduction in weight of material necessary to accomplish a specific purpose in structural engineering and resistance to deterioration by corrosion.

Another application which served to focus attention upon a property of as rolled nickel alloy steels further proved their importance to modern industry. This property was the ability of such steels to retain toughness at low temperatures, and a striking application was in the pressure vessels and auxiliary equipment used in dewaxing oils by the propane method.

Besides affording adequate protection from the embrittling effects of temperatures in the minus 50 to 75° F. range this nickel alloy steel plate was much stronger and tougher than unalloyed plate, thus permitting lighter construction with equal or higher factors of safety. This consideration of inherent strength was responsible, largely, for the introduction of similar plate into boiler construction. With nickel steel boilers, steam pressure increases of more than 25 per cent could be obtained safely without increasing plate thickness.

A problem which received attention was that of developing satisfactory properties in steel articles of such large section that the usual quenching and tempering operations were of little avail. Here the responsiveness of nickel alloy steels to simple normalizing or air-cooling treatments was of invaluable assistance. The attainment of higher strength through additions of nickel rather than by increasing carbon content not only assured maintenance of high degrees of toughness and ductility but also imparted superior resistance to "fatigue."

This was of the utmost importance in many applications, such as locomotive axles, where the effect of repeated stresses is the primary cause of failure. Realization of this fact required a complete reversal of the earlier idea that the way to avoid such failures was to raise the hardness and static tensile strength by any means possible, an idea which usually meant raising the carbon content.

In the field of alloy constructional steels generally used in the fully heat-treated condition, there was growing popularity of the nickel-molybdenum and nickel-chromium-molybdenum steels. In both the case-hardening and direct hardening grades, these steels combined high degrees of strength, toughness and wear resistance with good machinability and ease of handling in heat treatment.

Of special importance were the great gains in stainless steels. Improved metallurgical practice brought progress toward a stable austenitic structure through the addition

of nickel. Also, the advance in fabrication techniques — cold forming, hot working, welding — broadened the usability of the stainless steels.

Although stainless steel was not discovered until just prior to World War I, it was the decade preceding World War II that saw the first great advance in its production. More and more uses were being found not only in the heavy chemical industries where the combination of corrosion resistance with strength was important, but in railroad transportation where this same combination of properties made possible lighter sections with no sacrifice of the safety factor; and also many other fields such as architecture, food processing where cleanliness and strength with resistance to corrosion also were requisites.

The further development of nickel steel alloys was one of the most significant industrial events in the years of 1926–36; and, associated with that event, was the growing recognition by industry that progress in performance requires equal progress in the creation of materials to give that performance.

It was a development in which the metallurgists of the nickel industry played an active role. Working with them were research men in other metal industries. There still were years of depression for much of the world — but the common march toward the Age of Alloys was under way.

From the moment of its appearance in 1929, the company looked upon the depression as an interval in which the development of new uses for nickel was management's most important job.

In 1931, the copper market was demoralized, prices dropping to their lowest point in history; there were sharp and deep cuts in the prices of silver and platinum, and so heavy were the losses in these and other markets that the company reduced operating expenditures by 51 per cent under 1929. However, there was no letup in development and research and sales promotion activities. In 1931, development and research and sales expenditures were increased 25 per cent over what they were in 1929.

It was an action that emphasized two simple facts. One simple fact was that metallurgy and research are but the means of revealing and employing the hidden values of metals; the second simple fact was that it was an action which recognized, as Stanley said in his 1931 Annual Address:

"The Company's main activity has ceased to be that of mining. Its works and business are day by day becoming more commercial and widespread throughout the world, and the Company's success now depends less on the ore reserves than on the ability to find, or make, markets which will take the manufactured product of the Company."

Intent on the years to come, the company completed a plant and mine modernization program begun in 1926. The cost was $52,076,000.00. The year of completion was 1931. Encouraged because in the midst of depression it was doing better than maintain steerageway, Inco moved farther in the direction of expansion.

Millions of dollars were appropriated for laboratory and plant improvements; substantial amounts also were required for the acquisition of Monel-Weir Limited, in England, and the Ontario Refining Company Limited, operators of the largest copper refinery in the British Empire.*

*The Ontario Refining Company Limited was formed on April 1, 1929, to construct and operate an electrolytic refinery at Copper Cliff. Associated in

But, just the same, there were uncomfortable moments. From its beginnings, Inco had been in a unique position in that its output of copper depended wholly upon the tonnage of nickel produced. As elements of the same ore, the metallurgy was such that copper as well as nickel had to be carried through the entire process. For this reason it was impracticable to cut down copper production in a time when there was a steady, or rising, demand for nickel. Such a time was 1931.

In that year sales of nickel held up quite well (55,739,000 pounds) but copper sales were so poor, and copper inventories were so heavy, that at the end of the year producers representing 90 per cent of the world's productive capacity voluntarily reduced their output to about 25 per cent of capacity.

On June 2, 1931, the Canada Customs Tariff Act imposed a duty of one and one-half cents a pound on copper. A little more than a year later or on June 21, 1932, the Congress of the United States aggravated the already serious situation by imposing an import duty of four cents per pound on copper. The immediate result was to bar all sales of Canadian copper from their natural and most economic market. For a while it was feared that copper might become the jackstones of retaliatory international tariffs, but it came to be realized that, however unfair the import duties, nothing could be gained by retaliatory measures; and to be understood that, in large measure, the future of the Canadian nickel industry depended upon fewer — not more — trade restrictions.

In comparison with the millions of dollars distributed

this project were The American Metal Company of Canada, Limited, The Consolidated Mining and Smelting Company of Canada Limited, Ventures Limited and International Nickel which owned 42 per cent as did American Metal. In June 1935, the Ontario Refining Company Limited, became a wholly owned subsidiary of Inco.

by Inco in Canada each month for wages and salaries, for the purchase of commodities of all types, to railroads and to utilities, in dividends, taxes and for various Canadian services, the sale of the company's nickel products in Canada amounted to less than one per cent of the company's total sales.

Put another way, it meant that the company's export trade was becoming a substantial and growing factor in transforming Canada's natural resources into usable wealth for Canadians.

For Inco, the low point of the depression was reached in May 1932. Sales of nickel moved up, and moved up again in 1933 to 74,357,000 pounds, moved farther in 1934, and beginning to move with nickel sales were sales of copper and the platinum metals.

In 1935 more nickel, copper and platinum metals were produced than ever before in a single year; and 1936 was another record-breaking year when sales of nickel totaled 168,928,000 pounds, as compared with 129,850,000 pounds in 1935.

There were three important reasons for the company's early recovery from the depression. One was the augmentation of the research, development and sales activities under which nickel was introduced into new and diversified fields; a second was the installation of modern facilities throughout all the company's properties, thus widening the range and improving the quality of the products; the third was that nickel prices had remained very steady.

And, of course, there were other factors that contributed to the improved conditions. One was the electrolytic nickel process at Port Colborne which made

possible the more complete recovery of the platinum metals, as well as gold and silver.

Generations of chemists had experimented with platinum before some began to see that "it" was several metals in combination, in addition to being platinum itself. After long and bitter argument agreement came. There were six metals, all with high melting points and unusual resistance to corrosion, forming three pairs: platinum-palladium, iridium-rhodium and osmium-ruthenium.

In each case the first metal in each pair possesses almost twice the atomic weight and density of its companion; and the first metal in each pair has a higher melting point than its companion. Osmium, with a density of 22.6, is the heaviest known metal. Platinum and palladium are the most abundant of the six. On the basis of the amount produced, platinum and palladium are each about one hundred times as rare as gold.

Discovered in the Sudbury ores by Francis Lewis Sperry in 1888, platinum was a metal that everyone came to know was in the ores, but until the introduction of the electrolytic process at Port Colborne in 1922 it was a metal the recovery of which was uneconomic for International Nickel. And while platinum was the element whose presence was discovered by Sperry, it subsequently was learned that not only platinum but palladium, rhodium, iridium and ruthenium as well as gold and silver were present in the ore.

To Mond this source of profit was available — in fact regularly produced as a by-product of their nickel-refining process. They first sold their crude product to platinum refiners. By the early 1920's the profit from these metals had become so important that in 1925 Mond put into operation at Acton, London, a new platinum metals refinery designed and built especially for that purpose. It was the largest in the world. For its part, The International Nickel Company, whose ores, on the whole, were of lower platinum metals content and whose processes did not permit economical recovery, continued to sell the bulk of its platinum metals as an impurity in its nickel, since the cost of recovery was greater than the value.

Two things changed this: the opening of the Frood mine whose ore had a content of precious metals which made their recovery essential; second, the necessity for purer nickel to meet the requirements of the new high nickel alloys and the demand for better and better steels. For The International Nickel Company the solution was to turn completely to electrolytic refining. Following the union with Mond all platinum metals refining was consolidated at the Acton Refinery. With these changes the company became the world's largest producer of the platinum metals – and with this large supply arose the necessity for increased consumption.

In the early 1920's the statistics of the world's platinum business were very simple. The United States consumed two thirds of the world's platinum and used two thirds of this for jewelry. The rest of the world consumed one third but used two thirds of the one third in industry. The marketing problem was to expand the jewelry use in Europe and the industrial use in the United States. In the long run the industrial uses came to pre-eminence.

In part, this was due to the cessation of manufacture of platinum jewelry during World War II when all the available platinum was taken for war purposes. But chiefly it was due to new technological developments

such as the use of platinum spinnerets for the production of synthetic fibers and glass and platinum catalysts for the reforming of crude oil products, while palladium came into its own as a material for electrical contacts.

In the course of this work many new uses were developed and old uses confirmed. As is always the case with a group of metals, especially "noble metals," the uses are striking and varied: airplane spark plugs, laboratory and chemical factory equipment, dental alloys, jewelry. Using the ancient goldbeater's art, palladium can be beaten into leaves 5/1,000,000 of an inch thick and used in place of gold leaf in the decoration of leather-bound books or other leather objects. A thin layer of electro-deposited rhodium prevents the tarnishing of sterling silver. Platinum and platinum-clad titanium anodes are used in the protection of steel ships' hulls against corrosion.

More than twenty-one centuries separate the use by Bactrians of an alloy of nickel in coinage and the introduction by Switzerland, in 1881, of coins of pure nickel. It was not the first evidence of Switzerland's interest in nickel as a suitable metal for currency. In 1850, a Swiss monetary commission recommended the adoption of an alloy of approximately 62 per cent copper, 23 per cent zinc, and 15 per cent nickel for the country's minor coinage program.

The recommendation was rejected. The government insisted upon the inclusion of silver in the alloy so as to close the gap between the intrinsic and nominal value of the coins. The alloy was changed to include silver. The new alloy was so hard and so unattractive that it was unsuitable for coinage.

In 1881 the difficulty was finally met halfway by adopting pure nickel for 20-rappen coins, the cost of nickel being then about double that of an equal volume of copper nickel. The pure metal was therefore originally adopted for coinage purposes solely on the ground of its intrinsic value.

Between 1850 and 1879 nickel alloys were used in sixteen nations for minor coinage, but it was not until after the opening of the nickel deposits in the Sudbury Basin, and the availability brought about by metallurgical advances in its recovery from the ores, that the first great production of pure nickel coins was made possible. Within a comparatively few years one hundred and twenty-nine pure nickel coins were being minted for use in forty-three countries, and nickel was in third place after copper and silver, in the tonnage of metals used for world coinage.

In the order of their usage the metals were: copper, silver, nickel, aluminum, steel, iron, zinc, tin, magnesium, manganese and gold. Of the eleven metals, four (nickel, aluminum, zinc and iron) have been used in their pure state in recent years. All but nickel were found to be unsatisfactory. The material with the widest use in fractional coinage is cupronickel (75 per cent copper and 25 per cent nickel) which was developed by Belgium in 1860.

A user of silver coins for 2,000 years, Britain turned to nickel, and to other metals; so did India; so did China; so have the large silver-producing nations of Peru and Mexico. In 1951 Canada minted a nickel coin (five cents) in recognition of the two hundredth anniversary of the discovery of nickel by Axel Frederik Cronstedt. Nickel is steadily displacing silver as second coinage metal.

Along in the middle nineteen-thirties, representatives of the Government of China placed a trial order for nickel. In the years 1935 to 1939, inclusive, the company supplied the Chinese Government with over 5,500,000 pounds of pure nickel blanks for five, ten and twenty fen, or more than 590,000,000 coins. The practice that began in the seventh century B. C., when the Lydians shaped pieces of gold and silver into what numismatists say were the first coins, continues. Pieces of metal continue to be recognized as money.

Adolph Hitler was not long Chancellor of Germany when agitation against shipments of nickel to Europe was becoming epidemic in Canada. Overnight, almost, groups were calling for the abolishment of war and demanding of the Dominion Parliament that it place an "embargo on nickel as a means of preventing war." On March 21, 1934, legislation was introduced:

> . . . Whereas, nickel is an important material in the manufacture of armaments;
>
> Whereas, Canada furnishes ninety per cent of the world's nickel;
>
> Whereas, according to the League of Nations' reports the activities of the armament manufacturing concerns have been a considerable factor in causing unrest between nations;
>
> And whereas, the League of Nations has set up cooperative machinery for the control of the production and distribution of narcotics;
>
> Therefore, be it resolved that the Dominion government be requested to forbid the export of nickel to be used for war purposes, and also that the

> Dominion government request the League of Nations council to set up the necessary machinery for controlling the manufacture of armaments by private companies, and the exchange of raw materials used in the manufacture of armaments. . . .

The proposed act did not receive the approval of Parliament, but the agitation did not lessen. Mussolini aggravated the situation by sending an army into Ethiopia in 1935. Promptly, sanctions prohibiting the sale of nickel to Italy were imposed by Great Britain and Canada; at once, the company took steps to avoid any breach of the sanctions. The Ethiopian war ended in 1936. No Canadian nickel reached Italy. Instead of subsiding, as was hoped, the agitation was only quiescent. It broke out again, and became so general that, on March 29, 1938, Stanley devoted a major portion of his Annual Address to the subject, and emphasized a number of points:

> 1. We would welcome a situation which would be such that no part of our product would be utilized for war purposes. . . .
>
> 2. However, I would observe that it is doubtful if the cause of peace is served by one country, in time of peace, using its fortuitous control of natural resources as an instrument for attempting to control, or influence, the economic or political life of other nations.
>
> 3. The conception that nickel is primarily a war product, and therefore properly to be selected as a first field for experimentation, rests upon a conception of the facts as perhaps they were twenty years ago but which are not facts today.

> 4. The hands of the industrial clock have turned rapidly since the close of the Great War. Prior to and during the war, it is true that the greater part of the world's nickel production was used in armament. Today the converse is true, and all but a small part of the world's nickel is absorbed by industry for a multitude of peacetime uses.
>
> 5. Such armament use of nickel as survives is in connection with other metals such as steel and copper. Nickel is used because it serves as a useful alloy with these other metals. It improves the quality of steel and is a valuable constituent in many non-ferrous alloys. We recognized that these qualities could and should primarily be availed of for industrial purposes. We did not desire to have the Company's future rest upon the narrow base of a war material.
>
> 6. Nickel is of minor importance in warfare as contrasted with steel, copper, zinc and lead. Not only does but a small fraction of nickel go into armament, but the percentage that does go into armament represents a negligible percentage of the total of all metals used for armament purposes.
>
> 7. Even if it were possible to prevent any of Canada's nickel production from ultimately finding its way into armament, this would not hinder armament production. Canada produced in 1937 about ninety per cent of the world's nickel. The remaining ten per cent originated in New Caledonia, Norway, Germany, Greece, Burma, Brazil and Tasmania . . . is sufficient to meet the total world requirements for armaments.
>
> 8. The many new and diversified applications of

nickel furnish convincing evidence that your Company's exploitation of nickel for industrial purposes . . . has been a planned and successful revolution in the character of our business.

The report was well and favorably received, but the fear of war persisted. Sales of nickel in 1938 totaled 164,378,000 pounds as compared with 207,701,000 pounds in 1937.

14

A Searching Experience

IN 1939, for the first time in history, Canadians greeted their own reigning monarch, King George the Sixth, who, accompanied by his Queen, journeyed across Canada. Later, their Majesties visited Washington as guests of the President of the United States.

In Canada, it was the wish of their Majesties to learn something about the Canadian mining industry; and that is how it came about, on this day of June 5, that drillers working 2,800 feet underground in the Frood mine looked up in astonishment — a woman was standing where never before had stood a woman, because never before had a woman been underground in a company mine.* The woman was the Queen, and standing with her was the King.

*On July 25, 1959, Queen Elizabeth II and the Duke of Edinburgh also visited the Frood mine.

The implications of the visit of their Majesties to Canada, and to the United States, were not lost on the world.

In Europe, on March 16, 1939, Hitler's troops had occupied Bohemia and Moravia; on March 22, Hitler had annexed Memel; on May 7, Hitler and Mussolini had signed a military and political alliance. In Asia, Soviet Russia and Japan were fighting in Manchukuo. Now, everywhere in the world, people were looking upon the royal visit as evidence that the threat of war had subsided; perhaps, even, was stayed.

Within weeks, war was in possession of the headlines.

It is a strange and searching experience to be in the thick of a swing around when everyone has to drop his normal work to take on the military task of supplying materials to protect the people of many nations.

In the approximately twenty years that separated two World Wars, the character of Inco's business had changed. No longer was it a company depending largely upon armament, plating and coinage. It was a company whose activities were directed at supplying the commercial demand, and developing new demands, for nickel, copper and other metals.

It was a period in which it had strengthened its position of being the largest producer of nickel in the world as well as a period in which it had become one of the largest producers of copper, and of platinum metals.

Now, because of the superior qualities of these same metals in the production of the weapons of war, The International Nickel Company of Canada, Limited, was an important contributor to materiels of war. It was a situation which brought unfamiliar problems in security measures, market restrictions, hazards of shipping,

currencies, price controls; a situation that stressed the urgency of prompt action — at whatever immediate, or long-term cost — in supplying nickel, copper and platinum metals to the United Kingdom, and to its allies.

Also, it was a situation that necessitated the most careful handling of shipments to neutral countries — and, in the period before the United States came into the war, the task of supplying raw materials in quantity to England and to Canada, while continuing to serve the company's largest commercial market, the United States.

There was much information management could not divulge, which altered the customary relationship between management, the stockholders, the employees and the public. In addition, management was under official notice not to answer critics for fear of disclosing information valuable to the enemy.

It was a change that forced the discontinuance of all long-range planning, and substituted a program that called for the immediate tapping of carefully accumulated ore reserves, the opening of additional properties, the sinking of mine shafts, installing surface and underground plant and equipment, the enlargement of concentrating, smelting and refining works.

In the situation that confronted the free peoples of the world, national defense was not a debatable matter. Even if the steps taken by the company in the war effort destroyed the commercial markets of the company, built up over twenty years, they were steps that had to be taken.

The International Nickel Company of Canada, Limited, is a large company, and it was a large company when World War II began. During the war it almost doubled its output of ore. Its net profits in 1939, the first year of war, were $36,847,466; in 1945, the last year of the war, its net profits were $25,010,938 – a drop of $11,836,528. In further detail, each of the years – 1940–1945, inclusive – showed a smaller profit figure than the preceding year.

There is misapprehension, sometimes, as to the war profits of mining companies. As is obvious, mining business differs from other business in that a mining company spends its life in liquidating its assets. The metal in each ton of ore in the ground can only be sold once and as each ton is mined, the mine and with it the mining company is that much closer to extinction. To do this liquidation in the most profitable manner, it should be done in an orderly manner, mining according to well-developed plans, taking out all the ore to the lowest possible average grade and thereby maintaining a long and profitable life. War changes all this. Demand is for as much as possible, as rapidly as possible. Cost is unimportant. Orderly development of the mines becomes secondary. Higher than average grades of ore are mined to get more production, leaving behind permanently, ore which under an orderly procedure would be mined profitably.

On top of all this, tend to come fixed prices and increased costs and taxes. The end of the war finds the mines underdeveloped, overmined, overequipped, overstaffed, with management being left to struggle against the large accumulation of wartime stocks which must be liquidated on a diminishing market.

Early, Robert C. Stanley stated the company's position:

"The first obligation of every corporation, as of every individual, is to give the utmost support to his Government in the prosecution of the war. . . . In the vigorous

performance of this duty, we shall continue to develop the full measure of our resources and experience."

At the close of the first year of war, Stanley told the stockholders:

"The most important duty of your management during . . . the first full year of operations under wartime conditions was to provide an adequate supply of nickel, copper and platinum metals to meet all the demands for the war programs of His Majesty's Governments in Canada and Great Britain. Furthermore, the defense program of the United States Government, in conjunction with its policy of aid to Britain, is adding heavily to the toll on our output of nickel.

"To meet the situation we have not only continued our program of balancing smelter and refinery capacity with mine output, but have augmented and accelerated this program by making plant extensions wherever possible and utilizing all available facilities. In addition, we are treating and refining the entire Bessemer matte output of Falconbridge Nickel Mines Limited. . . ." The Falconbridge refinery in Norway had been closed by the war.

Providing an adequate supply of nickel, copper and platinum metals continued as the most important duty of the company, and joining those duties in the years of war were a multitude of responsibilities. In 1943, in his Annual Address, Stanley pointed out that "all these essential activities will have been pursued in vain if the political, industrial and financial leaders of the United Nations do not through wise statesmanship and by concerted action strive, without delay, to secure a just and durable peace."

A just and durable peace – it was a phrase he borrowed from a fellow director in the company, his friend John Foster Dulles.

The phrase "a just and durable peace" came from the Commission on a Just and Durable Peace. It was a Commission created by the Federal Council of Churches of Christ in America (now the National Council of Churches of Christ in the United States of America). As its chairman, Dulles spent a great deal of time traveling, making speeches and promoting the organization's purposes, just as on this day of March 18, 1943, he made a speech at the Rockefeller Luncheon Club in New York City, which was attended by Stanley.

The "six pillars of peace" proposed by Dulles were:

> 1. The peace must provide the political framework for a continuing collaboration of the United Nations and, in due course, of neutral and enemy nations.
>
> 2. The peace must make provision for bringing within the scope of international agreement those economic and financial acts of national governments which have widespread international repercussions.
>
> 3. The peace must make provision for an organization to adapt the treaty structure of the world to changing underlying conditions.
>
> 4. The peace must proclaim the goal of autonomy for subject peoples, and it must establish international organization to assure and to supervise the realization of that end.
>
> 5. The peace must establish procedures for controlling military establishments everywhere.
>
> 6. The peace must establish in principle, and

> seek to achieve in practice, the right of individuals everywhere to religious and intellectual liberty.

Deeply stirred, Stanley came to his office the following morning bringing with him sheets of paper on which he had scrawled paragraphs all bearing on the closing five words of Dulles' talk — *a just and durable peace*. Calling in Herbert G. Fales, a vice president, Stanley told of the meeting of the previous day, said he wanted a series of advertisements prepared that would reflect Dulles' words, and tossed the sheets of paper across the desk, saying, "Look these over, and let's get this program started."

Returning to his desk, Fales studied the scrawled sentences:

> Today Industry must speed production and intensify conservation in order to quickly win a victorious peace.
>
> Tomorrow, Industry must continue to produce in order to prevent unemployment leading to possible ultimate collapse.
>
> If the world is to prosper there must be the same cohesion among the United Nations in the post-war period as now exists during the world-wide conflict.
>
> Internal stability in the United States can only follow sustained industrial activity.
>
> In common with other industries, Nickel will prosper in the post-war period but only if plans, world-wide in scope, are formulated promptly for "a just and durable peace."

Fales called upon the company's advertising agency to prepare a series of advertisements based on the following theme:

Industry is helping win the war . . .
Industry must help build a peacetime world.

The theme was echoed in four appeals. The first urged "a just and durable peace"; the second called upon the people to begin thinking *now* upon what the terms of peace should be; the third emphasized that "a just and durable peace" can only come after thorough discussion; the fourth insisted that "only by exerting their will could people secure 'a durable peace.' "

Between April and December 1943, twelve advertisements were published in 250 magazines and newspapers in Canada and the United States. A comparable program was carried out in the United Kingdom.

The response was immediate. In Canada, the Ottawa *Journal* summed up editorial reaction in these words: "The great corporations of this country are meeting their responsibilities with loyal and realistic appreciation of all that is at stake in this war, and such advertising as that sponsored by International Nickel is bound to be of real service to the country."

In the United States, the Indianapolis *News* said much the same thing: "It is encouraging to see industry turning its advertising messages toward the great goal of a just and durable peace . . . as stockholders in America, they want to build safely and securely for the future."

The war came to an end in August 1945, and more than a year previously, protracted negotiations between the Governments of Great Britain, Canada and Russia, resulted finally in an arrangement for the payment, by Russia, for the nickel properties operated by Mond in Finland. They were properties which had been taken over by Russia at the end of her war with Finland.

In September 1944, Henry S. Wingate, then Secretary of the company, received a telephone call from Norman A. Robertson, Under Secretary of State for External Affairs in Ottawa, saying that settlement of the ownership of the Petsamo nickel deposits in Finland was under discussion at the Quebec Conference, and that advice was needed as to what Inco would consider a fair price for the properties seized by Russia.

"I will look into it, and let you know in a day or two," returned Wingate.

"That will not do," said Robertson. "I will have to have an answer within two hours."

With more assurance in his voice than he felt within himself, Wingate told the Canadian official he would call back. It was a weekend. Failing after repeated attempts to reach Stanley, who lived on Staten Island, in New York harbor, Wingate sat down with the few papers he had in his brief case, raked his memory, and reasoned within himself in reconstructing the history of the undertaking.

As the two hours neared its lapse, he reached for the telephone, made his call, and hearing Robertson's voice explained that he had not been able to reach his seniors, but "you can count on it that we will be satisfied with a price of fifty million dollars."

With the conversation ended, Wingate again sought to get in touch with Stanley. He finally reached the Chairman on the telephone, and told him of Robertson's call. Stanley's first question was: "What price did you quote?"

"Fifty million dollars," answered Wingate.

Stanley mulled over the figure, shook his head, and declared, "Harry, you quoted them about fifteen million dollars too much."

They arranged to take a train leaving New York that same day. Wingate missed connections at Harmon, a transfer point approximately thirty-five miles from New York City, but caught another train that permitted him to arrive in Ottawa at almost the same time as did Stanley.

The two men saw Robertson and discussed with him the details of the undertaking – of how the company had become interested in the Finnish properties, of talks through the Mond Company with the British Government as to the company's position in Finland when the war was ended, of a willingness to settle for $35,000,000, but of a preference to continue to operate under the terms of the contract.

After further negotiations with the Russians in Ottawa and Moscow, Robertson informed Stanley and Wingate that they, the Russians, had made an offer of $20,000,000 and said that, in the view of the Canadian Government, this was the maximum that could be obtained.

In presenting the figure to the Board of Directors of International Nickel, Stanley pointed out that while the company had invested nearly $7,000,000 and years of effort in development work, it would be difficult for the Canadian Government to press for a larger settlement. "I will agree," said Stanley, "that if the properties were in any other part of the world they would be worth a lot more than twenty million dollars. At the same time, considering the future hazards, I am in agreement with the views of the Canadian negotiators."

The directors accepted Stanley's recommendation. Robertson was notified. In substance, he reported back that the Russians were prepared to make a settlement for the properties, but they thought that this should be an obligation of the Finnish Government, that the Finnish

Government was going to be required to make reparations payments to Russia, that the payments should be made by Finland as a part of her reparations to Russia – all this, of course, with Finnish consent.

Robertson and Stanley were agreed that this proposal was quite unacceptable. As Russia was to be the beneficiary of the Petsamo property the obligation would have to be a strictly Russian obligation.

The Russians were informed that this was the Canadian view and they then made a second offer – in substance, as follows:

Russia would accept the obligation providing payments were contingent upon receiving from Finland the total reparations which Finland was going to be obliged to pay. Also, if payments were to be made over any installment period, the installments should be subject to any alteration in the schedule of payments arranged with Finland. In other words, Russia's payments were to depend upon the payment of reparations by Finland.

The answer of the Canadian Government to this proposal was negative. Negotiations were not made easier for L. D. (Dana) Wilgress, who was Canadian Ambassador to Russia, by this desire of the Russians to link the settlement of the Petsamo question closely with their reparations agreement with the Finns. In the event, as will be seen later, it was possible to avoid any direct reference to Finnish reparations in the protocol of settlement which was finally signed. The Russians were adamant that the period of payment should be six years – the same period as that provided for the payment of reparations by Finland.

There followed a long period of discussions as to what currency would be acceptable from the Russians. They first offered rubles. Rubles were refused. The Russians were informed that gold or United States dollars only would be acceptable. Instead, the Russians offered to pay in Finnish currency. This was refused. Finally the Russians agreed to pay in United States dollars, the value of which was set at $35 per ounce of gold. They also agreed in principle that payments would not be conditional upon settlement of her reparation account by Finland but would be set up strictly as a Russian obligation. Thus the arrangement would become a direct one between the Russian and the Canadian Governments and payments would be made to the Canadian Government for the company's account. It was agreed in principle that payments were to be made over a six-year period.

After negotiations between the Governments of Canada, the Soviet Union and the United Kingdom, a protocol to the September 19, 1944, armistice agreement with Finland was signed on October 8, 1944, by Wilgress and Sir Archibald Clark Kerr, Canadian and British Ambassadors in Moscow, and V. Dekanozov of the Soviet Foreign Ministry. It should be noted that the United Kingdom interest in these negotiations arose out of the fact that the nickel properties at Petsamo were held in the name of Mond, although all of the capital invested had come from The International Nickel Company of Canada, Limited.

In the protocol it was possible to avoid any direct reference to Finnish reparations but the Russians were unyielding in their stand that the period of payment should be six years, the same period as that provided for the payment of reparations by Finland. The text of the protocol follows:

On the occasion of the signing of the Armistice Agreement with the Government of Finland, the Government of Canada, the Government of the Union of Soviet Socialist Republics and the Government of the United Kingdom of Great Britain and Northern Ireland are agreed that:—

In connection with the return by Finland to the Soviet Union of the former Soviet territory of the oblast of Petsamo/Pechenga/and of the consequent transfer to ownership of the Soviet Union of nickel mines/including all property and installations appertaining thereto/operated in the said territory for the benefit of the Mond Nickel Company and the International Nickel Company of Canada, the Soviet Government will pay to the Government of Canada during the course of six years from the date of the signing of the present Protocol, in equal installments, the sum of 20 million United States dollars as full and final compensation of the above mentioned companies. For the purpose of this payment United States dollars will be reckoned at the value of 35 dollars to one ounce of gold.

Done in Moscow on the 8 of October, 1944, in three copies, each in the English and Russian languages, both the English and Russian texts being authentic.

For the next two years the Canadian Government regularly received payments in dollars as agreed from Russia, which payments were transmitted to the company. Five installments were received from April 1, 1945, to April 1, 1947.

In September 1947, after Robertson had explored the alternatives with Wingate, a supplementary protocol was agreed between Ottawa and Moscow under the terms of which the $11,666,500 U. S. dollars still at that time to be paid in seven equal installments should be paid instead in ten equal installments of $1,166,650 as from October 1, 1947, to December 31, 1951. This supplementary protocol was negotiated just after the Russians had granted the Finns a similar extension for the payment of their reparations. Thus the installment payments for Petsamo continued to be made on the same timing as Finnish reparations payment in spite of the insistence by the Canadian negotiators that the two matters should not be tied together.

On the basis of this supplementary protocol the Canadian Government received from the U.S.S.R. five regular payments — October 1, 1947, through October 1, 1949, in U. S. dollars. Just before the April 1, 1950, installment fell due the U.S.S.R. informed the Canadian Government that they intended to make the payment in sterling and, without taking into account the inability of the Bank of England to transfer sterling from Russian account to Canadian account, an instruction was issued by the State Bank of the U.S.S.R. for transfer to be made.

The Bank of England, on its part, reported to the State Bank of the U.S.S.R. that, under British Treasury Regulations then in force and under the terms of the Payments Agreement then existing between His Majesty's Government in the United Kingdom and the Government of the U.S.S.R., it was unable to implement the instruction.

The Canadian Government, on its part, expressed to the Russian Government that in its view the Petsamo protocol and the supplementary protocol were both explicit in requiring that payments should be made in U. S. dollars and that for the purpose of the agreements the value of the U. S. dollars was to be reckoned at $35 to one ounce of gold.

The Russian reply to the representations of the Bank of England and the Canadian Government came back almost immediately on April 13, 1950, when they notified Ottawa that payment of the April 1st installment was being made one-half in U. S. dollars and one-half in the sterling equivalent for which payment in sterling they had issued an instruction to the Bank of England (which could not be implemented) to transfer the sterling from Russian to Canadian account. During the period April 1, 1950, to December 31, 1951, the Government of the U.S.S.R. continued along these lines.

As each one of the last five payments fell due they tendered one-half in dollars which were accepted, with instructions to the Bank of England to transfer the other half in sterling. During this period the Russians had long discussions with the British claiming that under the Russo-British Payments Agreement such a transfer could be authorized; for their side the British argued that the Payments Agreement did not provide for such transfers. During the same time the Russians argued with the Canadian Government that if only one-half of the installments were being paid it was not because the Russians were defaulting but because the Bank of England kept refusing to make the necessary transfers in sterling. In turn, the Canadian Government insisted that the Petsamo protocols explicitly required that the payments should be made in U. S. dollars and the implementation of the Petsamo protocol could not, with any justification, be tied to the Russo-British Payments Agreement whatever its terms might be. At one stage in this period, the Canadians intimated that they might be prepared to accept gold as an alternative at the rate of one ounce for each $35 of indebtedness. The Russians displayed no interest.

Thus, at the end of the payments period, December 31, 1951, there remained in default the sum of $2,916,625 for which the Russians had attempted, without success, to transfer the sterling equivalent which they had refused to pay in United States dollars as agreed. In February 1952, in an effort to reach a solution, the Canadian Government told the Government of the Soviet Union that the Canadian dollar equivalent would be acceptable. The Soviet Government replied that it was not convenient for them to make this payment in Canadian dollars and rested on its position that its obligation had been completely discharged by its instructions to the Bank of England to pay one-half of each of the last five installments in sterling.

It was clear that a complete impasse had been reached and that further delay might end in eventual loss. Wingate went to London, beginning discussions with Treasury and Bank of England officers there, and to Ottawa for similar discussions with Louis Rasminsky of the Foreign Exchange Control there. In London various alternatives were discussed under which Inco might agree to make certain capital expenditures in Great Britain if, in turn, the Treasury would make it possible for sterling to be accepted in payment of the amount still due under the terms of the Petsamo protocol. Insofar as the Canadian authorities were concerned this method of payment was considered acceptable and, indeed, welcome.

The Russians offered no objections and left their instructions standing to the Bank of England to make

the necessary transfer from Russian to Canadian account to the amount of the outstanding unpaid balance of £1,041,650. After two years of negotiations a plan for the expenditure of this sterling in the United Kingdom through Mond was worked out which was acceptable to the British Treasury.

In November 1953, the overdue balance was transferred by the Bank of England to The Mond Nickel Company, Limited.

So far as the Petsamo mines were concerned, the books were closed. Inco had salvaged $20,000,000 in settlement from the Soviet Government, but there remained about $700,000 in miscellaneous assets outside the Finnish territory ceded to Russia. After approximately another four years, or by June 1957, this account, too, was closed.

The Nickel Company's introduction to Finnish ores came as the result of a communication from Frankfurt, Germany, on October 27, 1930, in which it was stated that "a nickel-copper ore deposit has been found . . . near South Varanger, 30km distant from the coast in the neighborhood of an ice-free harbour, and that about 1,000,000 tons have already been determined." Known as the Petsamo area, the district bordered on the Arctic Ocean, a few miles west of the Russian port of Murmansk.

Company officials were interested, only mildly. Correspondence on the subject comprised perhaps half a dozen letters in the next two years. In this correspondence it was learned that the deposit was discovered in 1924 by members of the Geological Commission of Finland, a government agency headed by Professor J. J. Sederholm. It also was learned that a number of European nickel companies had been refused permission to work the property.

In June 1933, Inco's interest was stimulated by receipt of a letter to Stanley from Victor Hybinette. In his letter, which was written from Jackson, Michigan, where he was living, Hybinette said he had been informed by Sederholm that "friends in Finland would be glad to help me negotiate a contract with the government so that I could start a nickel company on the basis of this property. . . .

"Professor Sederholm tells me that they are figuring on a company with $200,000 capital, which at present quotations is equal to over 10,000,000 Finnish marks, and that they consider the ore in sight justifies the immediate building of a plant to produce something around 2,000 to 4,000 tons of nickel per year. As I understand it, all the Finnish Government is looking for is a guarantee that a certain minimum amount of money will be paid out in wages each year. . . ."

Hybinette had no wish to organize a company of his own, preferring to be a consulting engineer in the event negotiations with the Finnish Government worked out well, and to act as an adviser to the Nickel Company if such negotiations were undertaken. His services were retained. On June 22, 1934, Finland approved an agreement granting the company "the right to stake out a concession area."

Investigation was promptly undertaken and sufficient ore was found to justify proceeding.

The work of preparing the mine for production started with the planning and building of a town, the driving of an adit and sinking of a shaft to reach the ore; the building of a reduction works and of a hydroelectric plant to provide the necessary power. Completion of

this work was planned for the autumn of 1939 but the growing tension between Russia and Finland delayed its completion.

On November 30, 1939, Russia declared war on Finland. On March 12, 1940, a treaty of peace was signed by which Finland lost about 10 per cent of her territory to Russia, but kept the Petsamo nickel resources. On June 23, 1940, a telegram from the Finnish Legation in Moscow to the Ministry of Foreign Affairs in Helsinki revealed:

> Commissar Molotov stated that Russia is interested in the Petsamo nickel resources, located not far from Russia, and asked whether we would grant the nickel concession to the Soviet Union, or agree to the establishment of a Finnish-Russian company, or make some other arrangement. . . .*

On February 13, 1941, another telegram (Document 65, see source below) was sent to the Ministry of Foreign Affairs in Helsinki from the Moscow Legation:

> Commissar Vyshinski asked me to call on him . . . concerning the nickel problem. I said I had no more by way of instructions than our negotiations. . . . He stated several times that they have no ulterior motives, that their objective is economic, but that they want equality. . . . My remark that Britain had considered the matter in a different way had no effect. . . .

On June 25, 1941, Russia and Finland were again at war.

More than a year previously, or on April 24, 1940,

**Finland Reveals Her Secret Documents on Soviet Policy, March 1940 — June 1941* (Document 14). Published, Wilfred Funk, Inc., New York, 1941.

Stanley had used the medium of his Annual Address to the Stockholders to say:

"Events which occurred last autumn could not have been foreseen when we examined the nickel-copper property at Kolosjoki, in Finland, and subsequently, in 1934, secured a concession from the Finnish Government. While we did not appraise the Kaulatunturi Mine as a great property, such as our Frood Mine, there was a sufficient tonnage of ore of a grade to fully justify development.

"During the six year period 1934–39, inclusive, the ore body was opened up by a tunnel, shaft, and underground development, and a smelter and a hydroelectric power plant were under construction. Had no interruption occurred, nickel-copper matte would have been produced at this property not later than 1941. Since its acquisition in 1934 there has been expended a total of $6,723,908 and it is estimated that an additional $3,500,000 will be required to complete the project. The future of this property in Finland is problematical. . . ."

15

Prospecting By Airplane

The pincers of war clawed deep into the company's ore reserves. In the years that separated the invasion of Poland and the surrender of Japan, and in round figures, we supplied the Allied Nations with 1,500,000,000 pounds of nickel, 1,800,000,000 pounds of copper, 1,800,000 ounces of platinum metals, along with 12,900,000 ounces of silver and 425,000 ounces of gold. It was an expenditure of ore that was an invitation to disaster, because it was production three quarters of which came from deposits discovered prior to 1920.

The old method of mining was to find a deposit, mine it as quickly as possible in the most profitable manner possible, and move on when the mine was exhausted, leaving a ghost town. Inco is not in the business of making ghost towns. It is in the business of operating a continuing business. From a local point of view, and from a national point of view, it is essential that mines be conserved over a long, regular period.

If a mining company is to have a continuing business it must continually add to its ore resources. If it is to be a growing business it must get larger and larger ore reserves. Together, these two things mean that one of the chief obligations of the management of a mining company is to maintain ore reserves; and, in a company where the constant effort is to serve more and more people, it is necessary to proportionately increase the ore reserves.

To get ore reserves of its type, Inco has to find a certain kind of geology. The geological maps of different countries are studied and, having determined where there are good possibilities, a closer look is taken. To merit a closer look, the geology must indicate the possible presence of ore in substantial quantities.

It is a search in which the company has been engaged for a long time. The primary purpose in obtaining new deposits is to build growing markets without shortening the company's life and to effect economies and therefore lower production costs. It is only by improving operating methods, and equipment, that the company can offset rising costs in taxes, wages, transportation facilities and other operating expenses; and economies and lower production costs can be accomplished only on the basis of adequate reserves.

Throughout the war, and at every opportunity, Stanley voiced concern over the drain on Canada's known ore reserves, and the effect of the heavy withdrawals of ore on the future of Canada's mining

industry. Calling for government encouragement and help to prospectors, Stanley invited all "who are interested in Canada's great mining industry* to stop and think of the 'wasting assets' upon which their business is dependent," and added:

"The point to be emphasized is that when the ore goes, profits and jobs go also. It is, moreover, fair to say that unless our taxing authorities give due recognition to the wasting nature of mining assets, irreparable harm will come to the Canadian mining industry."

On its own, the company did a great deal of exploration and diamond drilling in the war years. So much so, that on December 31, 1945, its ore reserves were estimated at 217,373,000 short tons of ore containing an estimated 6,866,000 short tons of nickel-copper — this in spite of the more than 70,000,000 tons of ore, all from the Sudbury district, which were mined in that period.

In its exploration activities, the company was re-examining the Sudbury Basin; was traveling the Porcupine district a hundred miles north of Sudbury; was skirting the edges of the Arctic Circle in the Northwest Territories and was looking closely at the tropical provinces of Miranda and Aragua, in Venezuela.

Called engineers and geologists, the modern prospectors soon were patrolling the remote places, using such accessories of science as airplanes, helicopters, magnetometers, gravity meters and scintillometers. Even so, they had not displaced the prospector

*Mining is second among Canada's primary industries. Agriculture is first, and forestry is third. Since 1943 the Canadian government has recognized as an essential business expense deductible for income tax purposes all prospecting, exploration and development expenses incurred while searching for minerals in Canada.

whose tools were his legs, his eyes, a prospector's hammer, a compass, a canoe and a thirsty curiosity. Traveling light, and inexpensively, he was the one who was doing the initial work.

j. f. t.

ONE day in August 1946, people in Sudbury looked up to see an airplane flying back and forth in a fixed pattern over the area. Suspended from a cable beneath the airplane was a bomb-shaped object carrying a magnetometer. Scientific methods were taking the place of a prospector's hunch.

Before World War II, the Gulf Oil Company, among others, experimented with airborne magnetometers in exploring for oil. During the war the United States Navy, as the result of intensive work by the Airborne Instruments Division of Columbia University, and a joint effort between the Navy and the Bell Laboratories, redesigned the device and used it in the detection of submarines. After the war, the United States Geological Survey modified the military features of the equipment. It was this equipment that was being used as an ore detector in the tests that were carried out in August 1946. The results were encouraging.

In January 1947, the Aero Service Corporation, of Philadelphia, Pa., was employed to fly an airborne magnetometer survey to locate sulfide ores by magnetic methods.* It, too, was conducted over the Sudbury area and was the first commercial application of the airborne magnetometer in the field of metallic mineral exploration. The results were disturbing. The Pre-Cambrian

*The sulfide minerals containing nickel, iron and copper, which are the source of the company's metals, are magnetic.

rocks of the Sudbury Basin contained much greater quantities of magnetite than had been suspected, causing geologists to grieve, as one did:

"The rifle aimed at magnetic nickel bearing sulfides turned out to be a shotgun. . . . We were confronted by the fact that magnetite in its infinite variety of occurrence produced anomalies similar to the magnetic anomalies resulting from nickel-bearing sulfides. Furthermore, we discovered that these undesirable magnetic concentrations were much more abundant and widespread in the Pre-Cambrian rocks than we could have imagined prior to the development of the airborne magnetometer."

It was clear the equipment in its existing form was of limited value to Inco. It was interesting to learn that the district had a multitude of magnetic anomalies, but it was not possible to distinguish which were barren of sulfides. The final test in exploration is, of course, to diamond drill an area and secure samples of underlying rock and associated minerals, as well as of ore. But diamond drilling is expensive and a company could go broke in making investigations. Taking them as they come, about ninety-nine out of every one hundred anomalies are barren.

If headway was to be made along the indicated lines it was apparent the company would have to have a device that would give additional information and, at the same time, it would have to be a device that would weed out useless information.

While the situation was under study, one of the company's executives was aproached by a small group of young scientists in Toronto. The young scientists were engrossed with the possibility of securing information on the conductivity of the earth from a low-flying airplane.

The idea seemed absurd, but it was worth looking into to determine if (1) it was possible to do this, at least in principle, and if (2) it was worth while for the company to attempt it.

Detailed discussions were had with a number of competent scientific organizations, some of which had experience with airborne magnetometers and were familiar with the difficulty of establishing a strong alternating magnetic field in the airplane — and to determine the effect of the earth's conductivity upon this field at a point several hundred feet from the airplane. This involved trailing a pickup device from a long cable, and flying it to measure the conductivity of an ore deposit, or other conducting body located near the surface of the earth.

The best opinion the company got was that it might be possible to locate "a highly conductive sulfide ore body" with this equipment on the ground but it would be impossible to do it from an airplane or from a trailing instrument.

Despite the thoughtful opinion of the best-informed, Inco concluded that the stake was so large that it was worth a substantial amount of money to continue the experiments and to find a way, if possible, to accomplish what could be a most important development. After many discussions, arrangements were made with the small group of young scientists in Toronto to take the next steps. Calling themselves the McPhar Engineering Company, they went to work; and Inco went to work with them.

A plywood airplane was secured. This was essential because a metal aircraft would have made the operation impractical at this stage of development. Primarily, the construction work was carried out by McPhar, but much of the equipment was procured on Cortlandt Street, in

New York City. This included accurate altimeters which were essential to low flying, electrical generators which supplied power in the oscillators on the plane, and many other components that became available as war surplus.

In many ways, the Anson plywood airplane was suitable. It had two motors and flew comparatively slowly, about 120 miles an hour. Unfortunately, it could not be fitted with floats, which made it necessary to use an air field, or a frozen lake, for a base. For this reason and because of the proximity of the Whistle deposit, experimental flying was conducted from North Bay, Ontario. The Whistle deposit was considered a particularly good test area because it had been subjected to extensive diamond drilling, and the ore occurrences were well defined.

The experimental flying continued for some time, with each flight reporting negative results. Pessimism began creeping in and then began to mount. Finally, and with almost everyone in the dumps, someone suggested "one final experiment." It was an experiment that called for a simplified method of electromagnetic pickup. The experiment was made the following morning. It worked, and it was the first indication that the method under test was practical.

Internal trickery in the equipment was the cause of the previous failures. The "one final experiment" eliminated the misleading elements, and provided much-needed encouragement.

Later the power of the oscillator was increased through the use of new generators and improved equipment was developed by the Nickel Company. Gradually, the A.E.M., meaning airborne electromagnetic device, which for two years had been given top attention, became operational.

Like a compass, the airborne magnetometer depends upon the intensity and direction of the naturally occurring earth's magnetic field. This natural field of force deviates in the presence of a magnetic material and the deviation is recorded as a magnetic anomaly.

The electromagnetic equipment developed by Inco produces its own field of force in the form of electromagnetic waves. In the presence of a conducting material such as nickel sulfide the characteristics of the electromagnetic waves are changed. This change is picked up by a tuned coil and amplified by electronic methods in the trailing bomb, or bird, and registers as an EM anomaly on the recorder carried within the aircraft.

Surveys are now made using both the magnetic and electromagnetic systems simultaneously. Nickel sulfide ores are magnetic as well as being conductive. As a logical sequence to the use of both types of equipment, the geologists concern themselves only with those anomalies which exhibit both these properties.

Synchronized with the magnetometer and EM recorder is a continuous strip camera which makes photographs of the flight line. By comparing these photographs with the aerial photographs used for laying out the area, the location of any anomaly may be plotted on the latter and transferred to a map for use by the field crews.

Inasmuch as more than 90 per cent of the company's exploration is in areas chosen by the Geological Department, it is important, before a district is selected for a close look, that the geologists be satisfied with the appearance of things. The selection of an area for a detailed examination is a decision that involves a great deal of time, a great deal of effort, and a great deal of money. Because the primary search is for nickel-copper deposits, with unique

properties that usually occur in a particular geological setting, the problem of selecting an area is narrowed down, but not made easier.

It took a little time, but it was learned that Nature is generous in her distribution of sulfide anomalies, and stingy in the bestowal of any favors. As stated a moment or two ago, there are at least ninety-nine barren anomalies in most Pre-Cambrian ores in Canada for each deposit containing values which may — or may not! — prove to be ore bodies.

Commercially productive nickel-copper sulfide deposits are of two principal groups. One group, which may be called the Sudbury ores, consists of deposits in which copper and nickel are present in fairly even amounts. These deposits are found with intermediate rocks of the Norite type. The second type of nickel-copper sulfide deposits usually has a much higher nickel-copper ratio. This type of ore is found with ultra-basic rocks of the peridotite type.

Before 1930, what was called the Mine Engineering Department did almost all the geological work in the company's search for ore deposits. And, in this connection, it may be pointed out that magnetometers, mounted on the ground and measuring the strength of the earth's field at specific points, had long been used in prospecting for ore.

The earlier versions, which, in effect, were dip needles, were augmented by precision instruments which were supported on tripods and required rather careful leveling. The principal instrument of this type was the German Askania and the Hotchkiss Superdip.

In 1930, the work was turned over to a new department called the Geological Research Department. The geologists were given the responsibility for (1) finding new ore deposits and (2) assisting in the grade and recovery control of the ore being mined. In 1943, with increasing interest in the use of geophysical methods, there came a rapid expansion in the department. It became one providing employment to many geologists, geophysicists, surveyors, technicians and engineers. Maps are their textbooks. The world is their classroom.

When the decision is made to take a close look at a particular area, an airborne geophysical survey is conducted. Aerial photographs are put together in a mosaic that shows a continuous picture of the district. Flight lines are drawn at one-quarter-mile spacing across the grain, geologically speaking, of the terrain. If the presence of uranium is suspected, a scintillometer usually is included in the equipment; if not, a magnetometer and electromagnetic equipment are flown over the photographed area.

The magnetic and electromagnetic results are turned over to senior geologists and geophysicists for study. It is work that is very exacting. In completing the studies, the senior geologists and geophysicists make evaluations and from these evaluations determine if there should be additional tests by field parties charged with ground examinations.

Ordinarily, a field party is made up of geological and geophysical personnel. Being experienced, they are able to position the anomaly with reference to lines of longitude and latitude. The anomaly is plotted on the air photograph which the ground party uses as a guide. Almost always, the cause of the anomaly is found within two hundred feet of its indicated position.

After the field party reaches the plotted position of the

anomaly the electromagnetic equipment is set up and a series of four lines are read around the transmitter with the receiver. These grid lines are in the form of a square, and are placed at distances of 400 or 800 feet. Additional electromagnetic work establishes the direction, or trend, of the structure of the anomaly. To gather further information, the magnetometer is then used to run magnetic profiles across the conductor. With these details out of the way, the field crew plots the local geology.

If geological and geophysical conditions, in combination, are advantageous, a more detailed ground survey is conducted. Upon completion of this survey the anomaly under scrutiny is ready for final appraisal. The decision to drill is made by the Chief Geologist after consultation with his assistants. Drilling is the largest cost item in the locating of new ore deposits, varying from $3.50 a foot to approximately $15 a foot. It is the final test in the search for an ore body.

It will take time, but a land so rich, and empty, as northern Manitoba is sure to fill up. Sixth in size of the ten provinces, Manitoba contains 251,000 square miles, ranking behind Quebec, Ontario, British Columbia, Alberta and Saskatchewan — and, although ranking sixth, is larger in area than any state in the United States excepting Alaska and Texas. At the same time, Quebec is larger than Alaska; Ontario is larger than Texas, so is British Columbia; and the Northwest Territories are large enough to contain Quebec and Alaska and have enough room left over to find lodging for the states of Illinois, New York, Massachusetts, and New Jersey. . . .

On its south, Manitoba borders the states of North Dakota and Minnesota; on its west it borders Saskatchewan; on the east, Ontario and Hudson Bay; on the north, the District of Keewatin of the Northwest Territories. Within Manitoba's 251,000 square miles are 39,000 square miles of lakes and rivers — rivers such as the Nelson whose swift-running waters empty into Hudson Bay.

Hudson, Button, Kelsey, La Vérendrye, Selkirk—these are storied names in Manitoba's heritage. Theirs were the footprints that became the path of a nation's westward progress. . . .

Henry Hudson, a British sea captain, was cast adrift by a mutinous crew (about 1611) to die off the stormy shores of the great bay that carries his name. Sir Thomas Button, a Welshman, sailed Hudson Bay, wintered at the mouth of the Nelson River in 1612, and was the first white man to walk on Manitoba soil. Henry Kelsey, a Hudson's Bay trader, crossed the province from Hudson Bay to The Pas in 1691, and was among the first white men to see the Canadian prairies. . . .

Pierre Gaultier de La Vérendrye was the leader of a group that, in 1738, came overland from the St. Lawrence to the western prairies. He built Fort LaReine in 1739, and was the first white man to reach what is now southern Manitoba and North Dakota. Driven by strife from their homes in Scotland in 1812, Lord Selkirk's exiles came down from Hudson Bay by the long river route, riding and walking, the women with babies strapped to their backs. . . .

A piper cheered them over the lengthening miles and led them, bagpipes skirling, as they came into the settlement at the junction of the Red and Assiniboine rivers, a settlement that has become the city of Winnipeg. . . .

A land of rivers and lakes, many of the rivers being little more than waterfalls and rapids linking chains of

lakes, of steppes underlain by rocks of different geological periods, of swamps, floating open bogs, hummocks, muskeg, of deep snows, long winters and storms slashing in on the winds that cross Hudson Bay from the Arctic, Manitoba is a land bearing, in abundance, the scars of a past when it was overrun by glaciers. . . .

And, too, a land of prairies, of waving grain, of warm sunshine, of friendly rain, of balsam, spruce, birch, aspen, jack pine and flowers, a land where, although now greatly lessened in numbers, are beaver, muskrat, martin, mink, bear, otter, moose and caribou, where great migrations of geese and ducks crowd the skies and reminders of an earlier culture dot the earth, in the finding of bits of pottery, and hammers, and pipes, and scrapers of stone.

After the conclusion of World War II when their copper-zinc deposit at Sherridon, Manitoba, was nearing exhaustion, Sherritt-Gordon Mines Limited began intensive exploration of certain nickel-copper showings it had discovered in the Lynn Lake area of Manitoba some 100 to 150 miles to the north. Diamond drilling indicated a substantial tonnage of ore. After transportation and metallurgical problems had been met and financing arranged, Sherritt-Gordon proceeded with the construction of a mill at Lynn Lake and a refinery at Fort Saskatchewan to process and refine the ore. Production began toward the close of 1953.

Inco began prospecting in Manitoba in 1946 when, with aerial supply support, geological reconnaissance teams traveled water routes of the Canadian Shield to study geological structures. They hoped to find rock types usually associated with nickel. They were not overcome by enthusiasm. In the Sudbury Basin outcrops indicating ore deposits were frequent; in Manitoba glaciation had cut deep into the soft basic rock known as peridotite with which nickel is associated. As a result of the glaciation nearly all the peridotite rock was covered by water, or buried in the valleys under glacial silt.

The first efforts were in the Lynn Lake district far up in the northwestern part of the province. In 1947, a team was in the Bird River area about one hundred miles north and east of Winnipeg, while another team was in the Jackfish Lake district about sixty miles east of Flin Flon. Here there was an interesting belt of geological formations that led in a northeasterly direction.

Thirty years previously field work had been conducted in the district by a geological survey team from the Department of Mines of the Dominion government. The discovery of gold-bearing quartz veins at Amisk Lake in Saskatchewan, a few miles from Flin Flon, in 1913, had drawn attention to the belt of Pre-Cambrian rocks in northern Saskatchewan and northern Manitoba. A year later gold was found at Wekusko Lake, in Manitoba, about 125 miles east of Amisk Lake. In 1915, a copper and zinc sulfide deposit was discovered at Flin Flon.

In 1920, F. J. Alcock, of the Canadian Geological Survey, published the result of two years of work in mapping the district. In his report, Alcock said the surveys were made "by means of the Rochon micrometer and surveyor's compass, with telemeter surveys substituted on portages and winding streams. . . . The smaller lakes and streams which could not be reached by canoe were located by pace and compass traverses, with ties, wherever possible, to more than one fixed point."

In 1948, the first magnetometers were riding the skies over Jackfish Lake and mapping more terrain in a day

than Alcock and his field crew were able to cover in almost two summers. Before long, the survey was moving along a geological formation that led in a northeasterly direction. It held promise. By the end of the year, geological and geophysical ground crews were ranging still farther, and were assessing airborne anomalies over an area 25 miles wide and 125 miles long.

Many times in the survey the anomalies picked up on the airborne equipment proved sufficiently interesting to warrant the taking of a close look on the ground. Each time a geological and geophysical investigating crew of three or six men was flown in, landing on the nearest convenient lake. Their first job was to set up camp. Having done that, they made their way through the bush to the magnetic anomaly.

After a pattern of grid lines was established (this for the purpose of obtaining further information as to the direction and structure of the anomaly) and with the anomaly continuing to hold promise, a tractor and diamond drill were flown in, after which a road was built from the camp to the spot under investigation. Drilling began. In each case core samples of the anomaly were taken. Of the two cases where it had been necessary to option property the drilling showed that one property in the Herb Lake area was worth holding.

By the end of 1955 survey teams had covered a total length of 340 miles. In the ten years of exploration there had been moments of enthusiasm, and periods of disappointment.

In 1949, the company was working in the vicinity of Mystery Lake, some 150 miles southeast of Lynn Lake. The airborne magnetometer gave strong indications of the presence of magnetic material in the immediate area of Mystery Lake. Investigating, it was learned that the property, originally claimed in 1927, had been restaked in 1949, shortly before Inco became interested. The new owner of the claim was in a mood to option, the company was willing.

Drills were put to work. Many months later, and one million dollars wiser, the drills were put away. After boring about 130,000 feet of test holes, no nickel deposits of present economic importance were found.

There are times in the mining business when there is no way to tell what is hidden until there is a complete search. All there is to do is to keep plugging away, confident that if a deposit is to be found, this is a good place to look.

In this case, the preliminary work indicated a very large deposit, maybe five or six miles long. The mineralized material was low grade, probably too low to be commercial. Drilling was continued, and it was learned that as the deposit deepened it dipped under the lake. It was pretty clear that the lake would have to be drained if any mining was to be done. The drilling continued, and some interesting results were obtained.

They found a good many stringers of good grade ore, but none was big enough to be of much use. Not only that, but as the drilling continued it was found that the deposit bottomed out sooner than expected. What was being done, and what was being found, were of great interest to the mining engineer, the mineralogist and geologist.

Exploration continued for hundreds of miles beyond Mystery Lake and, in 1956, the experts were gathered together to determine what property should be held from within a surveyed area that was about 340 miles

long and from twenty to thirty miles wide. By a process of elimination, the area of immediate interest was reduced to a length of eighty miles by some five to ten miles in width.

In the eighty miles were a large number of sulfide occurrences. A few held promise, among them a deposit at Moak Lake which was drilled as the result of anomaly investigations in 1952. In 1954, an exploration shaft was sunk. Exploratory drilling began from two levels. Ore was found and much information was obtained as to geological, rock and water conditions.

16

An Area of Great Promise

WHEN engaged in a very vital thing such as exploring for minerals, one of the great problems is to prevent leaks. That being true, it is necessary that as few persons as possible in a mining company should ever be put into a position where they could be accused of leaking such information.

Naturally, this is a policy which brings the question: "Are executives, for the most part, less trustworthy than the geologists, geophysicists and engineers working in the vital areas of exploration?"

Trustworthiness is not the subject under discussion. Under discussion is the protection of information. Information is best kept when it is known by the fewest people. The geologists, geophysicists and engineers have to be in the vital areas. Most of the executives and others do not.

In 1956, the outlook in Manitoba still was uncertain. At Moak Lake drills were boring deep and bringing back evidence of a large, although not rich, nickel deposit. Along a strip of perhaps twenty-five miles to the northeast and another twenty-five miles to the southwest of Moak Lake, twenty diamond drills were fingerprinting anomalies selected by the greatly improved airborne electromagnetic equipment, and particularly one anomaly about twenty-two miles southwest of Moak.

As with the Moak, this anomaly was a discovery of the airborne equipment. There were no surface indications of the presence of ore, no sign that would have caused a prospector to pause, nothing that would have provoked him into retracing his steps for a second look. The ore was hidden under a thick blanket of muskeg and swamp. Yet, the electromagnetic equipment pointed unerringly to the deeply buried ore body.

Almost overnight diamond drills were bringing news so intriguing that it soon appeared that, in combination, the ores of the two deposits probably would show a nickel content slightly greater than the nickel content of the average ore then being mined at Sudbury. It was one of the most important discoveries, and one of the most important events in the company's history. It was a discovery that came wholly as the result of scientific efforts. Left to old-style prospecting, the deposit would have remained hidden through eternity.

It was at a meeting in February 1956, that the Chairman said to the directors: "Late yesterday afternoon a telephone call came in from Manitoba to Wingate. Ralph Parker was calling, and saying: 'It looks like we've hit the jackpot!' "

Over the following months the discovery was found to be so important that by joint announcement on December 5, 1956, Premier Douglas Campbell, of Manitoba, and Henry S. Wingate, President of The International Nickel Company of Canada, Limited, presented a program of development that would involve, from all sources, an initial expenditure first estimated at $175,000,000.

By comparison, the ten million dollars the company had spent prospecting in Manitoba was small change.

On May 17, 1956, an urgent call had gone out from the Office of Defense Mobilization in Washington, D. C., for producers of nickel to meet "a revised expansion goal for nickel, aimed at providing a U. S. annual supply of 440,000,000 pounds of the metal by 1961."

Continuing, the Director of the Office of Defense Mobilization said: "At the new objective level, the available nickel supply for civilian and defense use, including the National stockpile, would be 140 million pounds above the present annual supply and 60 million pounds over the previous goal of 380 million pounds"; and, to emphasize the immediacy of the need, added: "To achieve the revised goal, two types of Government incentives are being authorized by ODM, rapid tax amortization . . . and Government purchase contracts. . . ."

The call for a production of 440,000,000 pounds of nickel to supply the needs of the United States economy (including government stockpiles) in 1961 was of biographical interest to the company. In the early years of the Canadian Copper Company, annual world production was about 2,000,000 pounds. Uses of the metal were confined to coinage, plating and German silver. In the intervening years, and largely as the result of the company's

efforts, nickel had become an indispensable metal with thousands of uses.

In response, representatives of International Nickel conferred with the Director of the Office of Defense Mobilization in Washington, advised him of "a program for new and expanded nickel production facilities in Manitoba and Sudbury," and made inquiries to learn if the company "would have equitable access to the U. S. national stockpile for a portion of any new nickel production if access were to be accorded for new production from Cuba."

The company was assured it would be in order for it to make a specific proposal, and was advised to meet with the General Services Administration. The company did so and while the G.S.A. late in November declined the proposal submitted, it confirmed that if it entered into contracts for new production in Cuba, consideration would be given to providing Inco with a right to deliver a portion of its new Canadian production to the U. S. national stockpile.

There were many things to do if the company were to succeed in bringing in this new production by 1961.

An ore deposit had to be opened. A town had to be built. Roads, electric power, transportation, had to be provided. Working directly with provincial authorities in the financial and contractual arrangements were Felix M. A. Noblet, William F. Kennedy, and Walter A. McCadden, Treasurer, Secretary and Comptroller respectively of the company.

With the possible exception of Henry Kelsey, who was said to have penetrated the area in 1691, Canadian traders from Montreal were first to enter the Burntwood River country where the deposits were located.

It was a wild country when Kelsey explored its lakes and streams and forests (if he did); it was a wild country in 1904 when H. R. MacMillan, now one of the leading lumbermen of the Canadian West, began cruising for timber; it was still a wild country in 1946 when geologists and geophysicists from the Nickel Company began opening the doors to its cupboard.

There are numerous lakes in the district, some of which are twenty to thirty miles in length, all with irregular shore lines. For the most part, the area is drained by the Grass and Burntwood rivers, each being a tributary of the Nelson River. Stands of spruce, birch and poplar are frequent. The terrain is rolling to flat. Bedrock outcrops are few and ridges of boulder clay and gravel rise to a height of 300 and 400 feet. Coming up from The Pas, and running through Sipiwesk on its way to Churchill, are the tracks of the Hudson Bay Railway.

As said, a lot of things had to be done, and the company had to start them right away. Two railroads had to be projected, one by the Canadian National Railways. This was a thirty-mile spur connecting Sipiwesk and the town-yet-to-be-built. The other railroad, an eleven-mile railroad, is a spur from the main Churchill line to the power plant site. A government-owned plant to supply electric power for company and town needs had to be built by The Manitoba Hydro-Electric Board.

To build a railroad and to set up a hydroelectric plant were matters that required negotiation. Urgent talks were held with officials of the Canadian National Railways and with officials of the provincial government.

The railway people agreed to build, and complete, the spur line before January 1, 1958.

In August 1956, thirty-five members of the Manitoba Legislature accompanied Premier Campbell on an inspection trip of the Moak district. The Water Resources Branch of the provincial government had conducted preliminary surveys at the Kelsey site during the summer of 1955 and the winter of 1956. Engineers of The Manitoba Hydro-Electric Board first visited the site in August 1956. Here was an available head of fifty feet and an estimated average flow of approximately 72,000 cubic feet of water per second. An initial installation of 200,000 horsepower would represent a conservative estimate of the potential power of Kelsey and an ultimate installation of approximately 400,000 horsepower might be feasible. This was the nearest and most economic site to develop that met Inco's requirements.

The initial cost of the project was estimated at from $32,000,000 to $38,000,000 for installations of 160,000 and 200,000 horsepower respectively. These estimates were for generation only and did not include transmission. To assist in its building, the Nickel Company made a loan of $20,000,000 to The Manitoba Hydro-Electric Board repayable in installments over the intervening period until 1980.

The joint action permitted the provincial government to begin its long-dreamed development of the water resources of the Nelson River (estimated at 4,000,000 to 5,000,000 horsepower depending on pattern of use; the site the Hydro-Electric Board chose for its power plant was about fourteen miles north of the nearest point of the Hudson Bay Railway); in turn, there was another result of the many conferences between government and company officials. One day when they were talking about the projected town, and speculating over a name, one of the company's people recalled that 1956 marked the fiftieth anniversary of the Chairman's service with the company, spoke of it, and suggested a name, Thompson.

There was acceptance by the provincial authorities. It was a generous compliment to the company, and to its Chairman who, at the time, was in Europe.

While these negotiations were under way, company engineers were scheduling the work on the two mines that had to be opened and developed. A concentrator had to be built. A smelter had to be built. So did a town. The site, which would contain 450 acres, had to be selected, cleared, and made ready to house an initial population of 8,000 men, women and children. These were things that had to be started.

A month's delay in initiating the programs could bring a penalty of a year's delay because of an inability to take advantage of the winter's freeze-up for bringing in, by caterpillar trains known as "cat trains," much of the heavy equipment needed to push forward the construction work.

Located 400 miles north of Winnipeg in a land almost without roads, and in a territory of 150,000 square miles almost without industrial production, the use of cat trains moving over the frozen lakes and rivers and muskeg was the only way of getting in the power shovels, cranes, fuel oil tanks and other heavy equipment, and the heavy tonnage of needed supplies.

The company made plans for the operation of day and night cat tractor trains between Thicket Portage and Thompson. Situated about fifteen miles south and west of Sipiwesk, on the Canadian National Railways, Thicket

Portage also was on the route followed by the Montreal traders who, many years previously, had explored the Burntwood country. By portage and canoe their route had led up from Winnipeg, across Lake Winnipeg and down the Nelson River to Split Lake. Probably they passed within forty miles of the present site of Thompson.

Freight began moving in from Thicket Portage in late October 1956. Running over trails lined with poplar, birch and spruce, and powered by big, bruising tractors, the cat trains beefed their way through snow and over ice in temperatures as low as 60 degrees below zero. Made up of eight to a dozen trailers, some as large as railroad freight cars, their crews outfought the blizzards, and shoved Manitoba's frontiers farther north by bringing to the properties more than 28,000 tons of heavy equipment and supplies in the winter of 1956–57.

Clearing the right of way for the spur tracks from Sipiwesk began January 13, 1957; blasting of rock cuts and grading of right of way began March 1; a timber trestle bridge spanning the Wintering River was ready at the end of March; because of high bluffs on each side, trouble was encountered in throwing a bridge across the narrow, but deep, Grass River; gravel for the ballast for the tracks had to be hauled down the Canadian National Railways from Pit Siding, eighty-six miles from Sipiwesk, but it was easier to do that than to tap the gravel pits four or five miles from Thompson.

There were other difficulties, but the spur that linked the town with the Canadian National Railways was completed six weeks ahead of schedule. On October 20, 1957, a spike* made of pure nickel was driven into

*The spike of pure nickel was presented to Major J. L. Charles, retired Canadian National Railways engineer, who engineered the job, following the ceremony.

place by Premier Campbell. The time-honored ceremony cleared the way for the first train, standing waiting, to move into the station at Thompson.

In contrast was another ceremony which had taken place at Churchill on April 3, 1929. On that day the Canadian National Railways completed its line to the port on Hudson Bay. In the excitement, someone forgot to bring a golden spike. An ordinary spike was used. It was wrapped in tinfoil taken from a tobacco can.

Things were going well at the properties, but had not gone well in Washington. Negotiating had come to an end on July 2, 1957. Washington had definitely decided not to contract for nickel from Manitoba. The decision was a disappointment. It meant that the new nickel-producing area in Manitoba was not to receive protection against the risk of surplus nickel production of the kind which Washington had decided to make available in Cuba.

With news of the rejection of Inco's bid, word also came from Washington, to the effect that with its requirements taken care of, "the Government isn't interested in nickel any more." This, as the company pointed out, was good news because it confirmed a great improvement in the supply outlook, and meant that consumers and producers no longer needed to fear the drain of nickel to stockpile.

Nickel had been in short supply for civilian purposes since the outbreak of the Korean War. This was due to the heavy demands for military purposes, coupled with large governmental stockpiling programs. The extraordinary demands lessened selling problems. At the same

time, they stood in the way of creating and developing markets.

Market development requires a continuing and assured source of supply, no matter what the article. Because the supply of nickel available to customers was below what was needed for established commercial applications, the amount that could be devoted to new uses was insufficient to permit launching such uses on the scale required to bring them to the stage of commercial development. As a result, the company's entire market development program was held up, and some projects were stopped altogether.

The opportunity of Inco to open mines in Manitoba started a chain of events destined to affect every department in the company. The first reaction was one of elation — Inco was going to produce more nickel per year, much more than anyone had ever dreamed; and it was going to be able to serve larger markets and more customers. After the initial rejoicing came sobering thoughts as to the significance of this new development. Questions were raised:

How badly had the markets for nickel been distorted and modified by the shortage? Could the substitute materials that had filled the gaps during the shortage be displaced by the original nickel materials or were new ones required? What were the most promising new markets for nickel and what was the character of the competition? These and other questions were intensified by the slackening in defense requirements and by the simultaneous opening of big new nickel mines by other companies.

The first positive step taken was the formal establishment of market research as a separate function. This was charged with the responsibility of identifying and measuring nickel markets, forecasting their growth and thus providing a quantitative basis for evaluating the job to be done. Then came the establishment of task force projects — specific efforts focused on clearly identified targets capable of expanding the market for nickel in a short period of time.

The responsibility for each project was assigned to a single individual who captained all the activities in regard to it and who could call on all the facilities of the company to accomplish the objective. Customer relations were the subject of a broad, intensive study and, as a result, many changes were inaugurated which had the effect of establishing a better understanding and closer relations between the company and its customers.

During this period the functions required to stimulate the growth of nickel markets were redefined in terms of current needs and the company reorganized to provide them. All departments were strengthened and some reoriented — sales, publicity, product development, technical service, market development and research — and, importantly, the functions were more tightly coordinated to provide an integrated over-all effort.

The new organization was imbued with confidence and with a sense of renewed faith and real purpose in the destiny of the nickel industry. History was repeating itself. The innovations in sales, research, development and publicity launched under Stanley's leadership in 1922 to solve the problems of that day gave inspiration for the parallel innovations necessary for the advent of Manitoba.

In keeping with the new conditions, the company released a statement, saying:

> The changing nickel atmosphere should stimulate new developments in the uses of nickel, and should help the nickel producers in their efforts to build civilian markets sufficiently large for the increased supplies to be provided by the Manitoba and other expansion programs.

In this changing atmosphere, there was no concession to disappointment. A lot had been done in Manitoba; a lot remained to be done.

At the plant site were acres and acres where as much as eighteen feet of clay and permafrost had to be removed before bedrock was reached — and bedrock, when reached, was needed to support heavy foundations for the concrete headframe for the mine shaft, the concentrators, for a smelter building covering 250,000 square feet, for a 500-foot smelter stack, for concrete ore bins each with a capacity of 22,000 tons of ore — general shops, including machine shop, plate shop, electrical shop, carpenter shop, a warehouse, change houses, a compressor plant, and all the outside construction necessary for a major mining operation.

Including supply yards, it was a surface plant that was rapidly taking shape on the 200 acres set aside for it. Two miles to the north, and in the trees on the high banks of the Burntwood River, another development was disclosing its outlines. It was the townsite. Between the townsite and the plant were the railroad yards, now in use, and an industrial area, soon to be in use.

Before 1958 was half gone, a change was made in the program. Originally, it was planned to bring the two properties (one, now called the Thompson mine, the other the Moak Lake mine) into production at the same time. The thought was to combine the low-grade Moak Lake ore with the better-grade ore from the Thompson mine in producing the scheduled 75,000,000 pounds of nickel a year.

Further investigation disclosed that, relatively, the Thompson mine was a much larger, and a much better, mine than had been realized. Two shafts had been sunk. One was at a depth of 1,057 feet; the other was down 1,382 feet. The shafts were 2,200 feet apart.

At the Moak Lake mine drilling was discontinued in 1958 after 118,000 feet of diamond drilling had been completed on two levels. Surface drilling had confirmed the presence of a large nickel-bearing intrusive at Moak that appeared to vary in width at different depths. Deeper drillings from an exploration shaft disclosed concentrations of higher nickel content ores, although in no instance was the concentration high enough to equal the ores in the Thompson mine.

The drillings also emphasized problems involved in (1) mining a large deposit buried several hundred feet below the overburden, and (2) mining such a deposit close by the shores of a fairly large body of water when the bedrock is lower than lake level, presenting a problem of water control. Fortunately, the rapid development of the Thompson mine provided time for study of the Moak Lake problems, as well as the problems at Mystery Lake.

They were studies that could be made later; in Thompson, traffic was moving over a graveled, four-lane highway connecting the townsite, the railroad station, the plant, and the Thompson mine. Between the Thompson and Moak Lake mines was a temporary highway over which trucks were rolling. When the highway was

finished, the working force was made up of about 1,800 skilled, semiskilled and nonskilled men, nearly all of whom were in jobs above ground.

A high percentage of the employees were from Manitoba — farmers, boatmen, bushmen, carpenters, electricians, plumbers, all sorts of people — and despite the remoteness of the place, and the long hours of work, there were thousands of applicants for jobs. For most, it was a chance to make a stake.

To illustrate, a farmer figured he could work between crops, which meant he could work six or seven months in a year. If handy with tools, and most farmers are handy with tools, he was classified as semiskilled. In the early construction phase when overtime was imperative, as semiskilled employee he was paid in the neighborhood of $600 a month. If able to do only manual labor, he earned about $400 a month. If skilled as a carpenter, or electrician, or whatever the trade, his pay check was around $900 a month. Food and lodging were provided.

Translated into things he needed, this was money that was a second crop for the farmer. It was money he could use in replacing an old barn with a new one, or in adding a barn; it could be used in putting a new roof on the house, or building an addition; it could provide new tools, more livestock, a larger farm, a child's education; it was money that could be saved. It was money that could mean many things.

And it did, as the company was told, many times, because it brought nearer to possession the things that were most wanted.

Translated into the needs of the company, it was money that was buying work and time. The deadline for bringing the Manitoba mines into production was 1961.

Frontiers are never easy, and they are never free. At Grand Rapid on the Nelson River, other men were pitting their strength against the tenaciousness of an untamed land. They were building a power plant against the same deadline. Dams and sluiceways were under construction; giant machines were ripping out a million yards of muskeg and permafrost — and were having trouble with the permafrost which penetrated to depths of 150 feet. This was work, with no time out for pie à la mode, or chocolate candy.

Naturally, there were contrasts. There was a summer day when company executives were sitting in an automobile. Pulled over to the side of the road at Churchill, on Hudson Bay, the officials were looking out over a military installation when a young lady appeared on the veranda of a soldier's quarters. Divesting herself of all her clothes, she spread a bath towel on the floor of the veranda and stretched out, face to the sun. It was an interesting sidelight on nature. Where the young lady was lying was bright, warm air; three feet below the level of the veranda floor was the permafrost evidence of an epoch when glaciers covered the province.

It was while the amused spectators were talking of this phenomenon that an older woman appeared in the front door of the cottage and stood looking down while sternly instructing the sun-bather to put on her clothes. The sun-bather was about three years old.

Interest in exploration did not end with the discovery of the Thompson, Moak Lake and Mystery Lake deposits, the building of a town on the Burntwood River, or with the fulfillment of the 1961 commitment. Up the tracks

of the Canadian National Railways, 300 miles from Sipiwesk, was Churchill. Beyond Churchill, and beyond the railroad, up in the barren lands were the Northwest Territories.

Before proceeding further, it may be well to point out that the development of an increased supply of nickel is quite a different problem than is the problem of increasing production in most manufacturing industries. In these industries — allowing, of course, for the necessary financial resources — essentially all that is needed is the courage and decision to proceed. In the nickel business, known ore deposits of a size, and type, suitable for the company's processes are extremely rare.

Knowing the importance of the need, the company has searched the world for years, and has spent a great deal of money, trying to find deposits large enough to make real additions to world supply. As part of this search, company geologists and geophysicists turned to Manitoba. In Manitoba, such a deposit was found. The search continues — in Saskatchewan, Quebec, the Northwest Territories, Africa, the West Indies, East Indies, anywhere and everywhere that has promise.

On December 5, 1956, when Premier Douglas Campbell, of Manitoba, and Henry S. Wingate, President of The International Nickel Company of Canada, Limited, made their joint announcement of the plan to develop the Mystery-Moak Lakes district, the company's confidence in Manitoba was expressed in these words:

> Apart from its importance as a new producing area which will substantially increase the world's supply of nickel for industry and defense, we are

enthusiastic about the part Inco will be playing in opening up what may well prove to be one of the greatest remaining frontiers. Today some 150,000 square miles in Northern Manitoba surrounding the site of Inco's operations are almost totally devoid of industrial production. This entire area will feel the influence of Inco's great industrial project and the future changes will be far-reaching in their effect.

On April 29, 1960, the Board of Directors met in Thompson and elected Henry S. Wingate Chairman and Chief Officer, and J. Roy Gordon President of The International Nickel Company of Canada, Limited. Elected Honorary Chairman, as well as continuing as Chairman of the Executive Committee, of the company was John F. Thompson. At the same meeting Ralph D. Parker became Senior Vice President and four new Vice Presidents, Ralph H. Waddington, James C. Parlee, Richard A. Cabell and Albert P. Gagnebin, were elected. Welcoming the directors to Manitoba for their first formal meeting there, was Premier Duff Roblin.

Comparatively, mining is a new industry in Manitoba. In the north and west are nickel and copper; farther south, but still in the west, are copper, zinc, gold, silver and other metals; to the west are gold and copper and nickel — with no major production prior to 1928. As with Ontario, this, too, is a region whose economic future is underwritten by the Canadian Shield. In a commercial sense, trapping and fishing were Manitoba's first industries. Agriculture was a major industry before mining, and still is.

Since 1670, northern Manitoba has been the house

and grounds of the Hudson's Bay Company. In its essentials, the conduct of the business has changed by little.

Its talents are in trade. Indians still are grubstaked, still follow the trap lines; Indian women still do beadwork and still make moccasins that are sold in company stores. Continued, wherever feasible, is the practice of supplying seeds and co-operating with the Department of Indian Affairs in encouraging Indians in the cultivation and growing of vegetables for family use.

Indian paddles still measure the rivers in bringing supplies to remote places but, for the most part, motorboats, barges, scow brigades and trucks have replaced the canoe. In winter, trails are kept open by tractor trains. The high-prowed, oared, hand-hewn York boats that were the cargo carriers of early years now ride out the gales under the shelter of museums. Distance is swept aside by a radio telephone network joining the posts; airplanes keep headquarters men in close touch with the entire operation.

Churchill, where the muzzle-loaders of old Fort Prince of Wales maintain their long watch over the Bay, still serves as the Hudson's Bay Company's seaport to the trade of Europe.

In the spring of 1892, two sheep-coated Galicians arrived in Winnipeg. They could speak no English, but they found jobs as farmhands. In the fall they disappeared, but returned bringing sheep-coated countrymen and shawled countrywomen leading children and carrying bundles. It was the first migration of the farmers from the Slavic countries of Europe to the prairies.

But before the first of the "sheep-coats," as they came to be called, had spied out the land, and while the hard wheat known as Red Fife, which was to shape the prairies to the plow, was being shipped in from Ontario, fishing was a commercial industry in the province.

While Sir John A. Macdonald was yet turning over in his mind the proposition of permitting Manitoba to extend its borders to Hudson Bay, fishing was being practiced commercially in Lake Winnipeg and Lake Manitoba. Whitefish, lake trout, pickerel and sturgeon were plentiful. In the early 1880's, Booth Fisheries was financing fishermen, much as the Hudson's Bay Company was grubstaking trappers, and was extending its efforts to Lake Winnipegosis. Over the years it has expanded its interests to include scores of lakes, gasoline-powered fishing boats up to forty feet in length, fish-filleting plants, packaging plants, quick-freezing plants, cold storage facilities, the smoking of goldeyes, whitefish, sturgeon and other varieties, and as a specialty, the packaging of pickles grown in Manitoba.

Inseparable from Manitoba's economy, present and future, is water power. Only 10 per cent of the total resources, or 750,000 horsepower, are located and developed on the Winnipeg River in Manitoba. With the exception of a proposed installation of 450,000 horsepower at Grand Rapids at the mouth of the Saskatchewan River, almost all the remaining water resources are in the northern part of the province.

The undeveloped sites are well distributed. Twelve are along the Nelson River (including the Kelsey site), ten along the Churchill and seven much smaller ones along the Seal River. To these can be added single sites on many other smaller rivers. It is possible that in the not far future there will be an interconnected Northern Manitoba Power System turning the wheels of an in-

dustrial development that is likely to be. The physical frontiers of the land will disappear in the scientific frontiers of the research laboratories.

The discovery in the Mystery-Moak Lakes District has permitted the Nickel Company to make a place for itself in this present and continuing development. To find another field for its service, or to find another service for its field, also is pioneering.

17

Building a Town From Scratch

IN the archives of International Nickel are two photographs taken in Copper Cliff in 1889. One photograph is of the tennis court in the village; the other photograph is of the village. As photographs they are not very good but, as a testament of the times, they are not replaceable.

The tennis court was laid out against a background of log sheds and log houses. The playing surface was not of grass, nor of clay, but was a combination. The grass was scattered and bunched in tufts; the clay was hard and uneven. The net was constructed of wooden laths, spaced perhaps an inch apart, and fastened to stringers which, in turn, were nailed to posts fixed in the ground. For spectators, there was a backless wooden bench, seating four persons without too much crowding.

Roosting along a bent-elbow-shaped ridge, the village

was made up of some three dozen buildings, mostly cellarless log houses. Off to the right, and below the ridge, were half a dozen similar structures. A narrow dirt road ran along the ridge, and dipping from it was a spur which linked the village with the stragglers and brought the settlement together. There were no sidewalks, no footpaths, no street lights, and no room for lawns, so closely did the houses hug the thoroughfare.

Leafless and almost branchless, three tall, spindly, dead pine trees stood below the road as reminders of the devastation of a forest fire. Tough and insistent in this north country, but soon to vanish in the fumes of the roast pile, underbrush, high grasses, wild asters and thistles spilled over into the dips and pockets of the valleys.

The first house in Copper Cliff was built for a Thomas Jefferson and the Canadian Copper Company, in 1885. Built of logs, with a steeply pitched roof, there were two doors, one at each end, front and back, and one small window. Living quarters occupied one end, the other end being for storage. The tangled forest in back of the house supplied fuel for a box stove. A few steps into the trees provided partridge, in abundance. Nearby lakes and streams provided fish. All that was needed to catch them was a prospector's tackle — a hook, a line, and a piece of red flannel.

The village grew around the mines and the smelter. The houses were small, and for the first years were built of hewn logs, with the spaces between filled with strips of wood set in plaster. It was an improvement over the use of moss to fill the crevices, as in the earlier houses. Usually, the houses contained a kitchen, a living room and one or two bedrooms. There was no protection against fire. When there was a fire, a bucket brigade was formed. It confined its efforts to wetting down adjoining dwellings, and left the fire to exhaust itself. The last log house was built in 1902. It was quite a pretentious dwelling, and was built by A. P. Turner, resident manager of the Candian Copper Company, in violation of his own instructions that no more log houses should be built in Copper Cliff.

Levack, Creighton, Coniston and Garson are other towns in the Sudbury neighborhood. The history of each is not greatly different from the history of Copper Cliff. In their early days, all grew in a helter-skelter way around the mines and smelter but, as with Copper Cliff, they are towns that long since have followed an orderly pattern of development and modern improvement.

To the south and west, seven miles from Copper Cliff, is Lively, sixth of the nickel communities in the Sudbury Basin. Named after Charles E. Lively, who began as a miner and became mine superintendent, the naming of the town came about in a very natural way. When the men who worked with Lively in the mines heard that the company was planning a new town, they talked about it among themselves saying, in effect:

"Wouldn't it be nice if the company named the town for Charlie? He's always been here; he's worked all the way through; he's been a mucker, a miner, he's been everything, and now he's a mine superintendent, one of the top guys."

The idea spread. The management and the Ontario authorities were much taken by it. They accepted it, and into the acceptance went all the work and pleasure of starting, and building, a town from scratch.

Begun in 1950, with the purchase of 1,100 acres of

rolling farmland, the town of Lively was laid out to include wide streets, semicircular in pattern to fit the contours of the land, and to permit landscaping, not only of the streets but of the residential lots.

Ten architectural styles were used in building houses of stucco, brick and wooden sheathing, each containing four to six rooms, full basements, hot-air furnaces, hardwood floors, every convenience. Soon there were churches; school buildings were built to meet the modern educational requirements of pupils up and through high school age.

A business block was designed to include a market, a clothing and drygoods store, a drug store, post office, a bank, a hardware store, a service station, a beauty parlor, and offices for a doctor and a dentist. Provided was a sports field, a parking lot — with all business and professional establishments being operated privately, and independently.

Newest of the nickel towns is the town of Thompson, in Manitoba. Here Inco started not from scratch, but from behind scratch. It is in a new country, in an area of 150,000 square miles, almost barren of industrial activity and of sparse population. The first house in Thompson was built in 1958.

One of the first problems in building a new town is the problem of setting the tone. Whoever is head man, so to speak, in the first days and who says "Things will be done this way, and not that way," will affect the entire life of that community. The tone of Thompson was set before it was a town. It was set when the exploration camp was opened at Moak Lake, fifteen or twenty miles distant from the townsite, and the company engineer let it be known that the standard of cleanliness which had been established in Ontario was to be maintained.

That idea of town cleanliness has carried over into Thompson. In fact, when there were no buildings at all in Thompson, permission to put up a temporary structure on the townsite was requested by an organization. The request was denied, with this explanation: "Temporary buildings have the habit of becoming permanent."

"Then, let us put up a tent," pleaded the would-be inhabitants.

"No. Not even a tent."

In building a town, time and planning also are required if a wilderness is to be changed into a modern community. Thompson was developed along these lines. As a result, the helter-skelter of unplanned frontier communities was avoided. The provincial authorities were as anxious as were Inco officials to have surroundings in which people would be happy to live.

Over at Moak Lake, while the building of the town was yet in the planning stage, a most comforting thing happened. The wives and the children of six or seven of the men started it. They began moving in. It was a most comforting thing because they came for the same reason families before them crossed the continent in Conestoga wagons.

They came that they might be together in a new land. The wives decided to join their husbands for the short summer and, of course, the children came with them. The arrangement was for the families to return to their homes with the coming of winter. When that time approached, the children set up such an uproar that surrender by the parents was a formality.

The summer in northern Manitoba had been a boy's

summer, and a girl's. The district was patrolled by the Royal Canadian Mounted Police; in the district were Indians and trappers and prospectors and men building a railroad. In the spruce and birch thickets out of which a townsite was being bulldozed were birds' nests and berries and wildflowers; the Burntwood River, on the banks of which the town was being mapped, was a place to fish, to wade, to swim, and skip stones; there were new places to explore, strange rocks to examine. . . .

And now, ice was forming; snow was beginning to sift down. Soon, there would be skating and hockey and iceboating; soon, there would be snowball fights, sledding, snowshoeing, skiing, tobogganing, snow for building forts, for games like fox-and-geese; snow for making angels, for following the tracks of moose and rabbits. . . .

It gets cold in Thompson. The latitude is 55° 41′ north. On the map, it is the latitude that cuts across North America through Labrador, James Bay and the Aleutian Islands. As the winters are long and cold, so are the summers short and hot. The average snowfall is about three feet. The small lakes freeze over in October, the large ones in November, with the ice staying until May, or early June. Rains fall mostly in the growing season, and the long days provide a great deal of sunshine.

Coming down from the north and west, the Burntwood River sweeps past the town on two sides. Located on a heavily wooded bluff rising fifty to one hundred feet, and rather steeply, above the fast-running water — and roughly triangular in shape — Thompson's winding streets and thoroughfares carry names such as Cree Road, Mystery Road, Thompson Drive; other names such as Silver, Cobalt, Copper, Nickel and Granite; others such as Juniper, Cypress, Poplar, Chestnut, Hickory, Walnut, Basswood, Hemlock and Ash. There are conveniently located business blocks, playgrounds, schools, churches and public buildings. Left standing are hundreds of black spruce, balsam, birch and poplar. The trees are small, but healthy.

There is a pumping station and a water treatment plant just over the townsite limits and, on the other side of the town is a sewage treatment plant. In the valley that swings below the town and the mines, runs the transmission line that brings power from the Kelsey station. On the other side of the transmission line are the terminal and the tracks of the Canadian National Railways.

The town is located in the Local Government District of Mystery Lake. In charge of the civic affairs of the district is an administrator appointed by the provincial government. At the request of the company, and subject to the approval of the provincial government, the Metropolitan Town Planning Commission of Greater Winnipeg laid out the townsite.

Facilities were provided — streets, sidewalks, electricity, sanitary and separate storm sewers, sewage treatment plants, automatic telephone, water mains, protection against fire, police protection, schools, medical care including a hospital, recreational facilities, municipal offices, an assembly hall, bridges, etc. — and, in large part, the company paid the cost of building them.

Under the contract with the provincial government, certain facilities provided by the company become the property of the town — facilities such as sidewalks, roads, lanes, an assembly hall, municipal offices, fire stations, sewers, water mains and schools. The stipulation pro-

viding that title be turned over to the town follows the pattern of this paragraph pertaining to schools:

The company agrees "within a reasonable time . . . and having regard to the requirement of the presently contemplated population of approximately 8,000 to construct and equip, or cause to be constructed and equipped, in the Townsite established . . . a building, or buildings, for a school or schools which will be vested in and become the property of the School District, containing a number of class and other rooms required by the regulations of the Department of Education, on a site or sites to be selected by the Resident Administrator, which site or sites will be transferred by the District to the School District free of charge."

Electricity is supplied by The Manitoba Hydro-Electric Board from the power plant on the Nelson River, at Kelsey. The company was the board's first customer for power from the plant, which also has a surplus of power for other uses.

Water is piped down from the upper Burntwood River. Streets were laid out to harmonize with each other, and with the surroundings. Landscaping was not easy, but was done. There are a good many flowers, including the lovely prairie crocus.

Mostly of frame and stucco, each house contains four to six rooms, bath, furnace and oil heat. Various architectural designs are used. The lots are wide and deep, providing gardens for family supply, and room for children to play in fresh air and in safety. There are facilities available for employees to purchase their homes in Thompson under the various provisions of the National Housing Act of Canada.

The shopping district is roomy, attractive and convenient. There are stores and barbershops, beauty parlors, markets, bowling alleys, an ice rink and a theater. Inasmuch as the town is located on land belonging at the outset to the Local Government District, there is Local Government District supervision of the development of the community.

Churches are of various denominations. They are needed here, as they are needed everywhere; the company has always been glad to have them. On December 30, 1889, in the minutes of the Canadian Copper Company, there is this resolution pertaining to Copper Cliff:

"Moved by McIntosh, seconded by Allen, that Mr. Evans be instructed to select a lot" and donate it for church and school purposes.

Although long and cold, the Manitoba winters do not keep people from wanting to go to a mining town to work. The announcement by the company of its intention to open a new mine and to build a new town 400 air miles north of Winnipeg, and 950 miles northwest of the Sudbury operations, was scarcely in the newspapers, so it seemed, when it had a long waiting list of names of people who wanted to go there to work and to live. It was the same way with doctors and with nurses. The doctors run the hospital and co-operate with other hospitals and with other doctors.

In its operations, the company deals with people of nearly half a hundred national origins. They work together. They get along together. In Manitoba, Indians are employed in various capacities. They are particularly good as boatmen and as bushmen. The men who work in the mines and smelters are of many races, and prominent among the mineworkers are people of Scandinavian origin. When they emigrate, they seem to

like to come to the same kind of country, and to the same kind of work. After the war between Russia and Finland, there was an influx of Finnish miners.

Considering the differences in origin, along with the fact that the different Inco communities in Canada have a combined population of probably 20,000 people, it is gratifying to note that crime is almost a negligible factor. Doubtless, there are many reasons; and among the reasons is the fact that the communities are populated by settled people.

Copper Cliff, Creighton, Coniston and the other towns were not boisterous. In large part, they were established by people from neighboring villages and farms — people who liked the north, and who were accustomed to its ways.

In building a town, all sorts of transient workers are used, but in the real sense, they are steady men. They are drifters in the sense that they do not stay very long in one place, but they work at their trades, and they follow their trades to the place where they are needed. When the work runs out, they merely move on — to where it is.

There are tennis and badminton courts, baseball diamonds, bowling alleys, swimming pools, football fields and golf courses; but it is in the ice rinks where the crowds are found. In the Sudbury district the skating season extends from December to March; in Manitoba, of course, the season is much longer. There is plenty of natural ice, but in a town there has to be clean ice for people to skate on when they want to skate.

This means that if the high school team wants to play against another high school team, there has to be a place to play. The skating rinks are built with the idea of converting them to the use of artificial ice — which is a roundabout way of saying when the time comes for frequent use of the rink for hockey, or for curling, it is necessary to have seats for spectators, and a roof to protect people from the elements.

Excepting for some smaller details, the over-all picture in all towns is pretty much the same. There is common respect for life, property and law. Acceptance in the community is determined by an individual's character. The same quality determines the public tone. Each town is a community of neighbors. In each town is unity, but not the unity that wants to make everything alike.

In Ontario most of the nickel communities are self-governing municipal corporations. The voters are company employees, but not exclusively. Often, those who are elected to manage the town's affairs are employees, but not exclusively. The company pays most of the taxes, but not all of them. In Manitoba, and under the terms of the Local Government District Act, the government-appointed administrator manages the affairs of Thompson pending the establishment of elected municipal government.

Where there is local government, the employees who are elected to help in the management of the community's affairs profit by the experience. As custodians of the public affairs of their neighbors, they are directly responsible to the neighbor next door, or to the neighbor across the street, to the neighbor that is industry and to the neighbor that is agriculture.

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Not Walled In By Horizons

In his first Annual Report in 1922, after becoming President of the company, Stanley informed the stockholders that "during the year a department was organized to develop new uses for nickel and Monel nickel-copper alloy and to extend their known uses." The moderate tone of the announcement was in keeping in size with the initial organization of a new Development and Research Department.

This establishment of a Development and Research Department was, however, only the formalizing of an activity which had begun at the formation of the company. The original activity was concerned only with commercial development, since at that time the company had neither laboratories, except chemical ones for routine analyses, nor any personnel trained in research.

At first, the work was on various uses for nickel steels in such forms as rails, boiler tubes and bridges, but with the coming of Monel alloy the emphasis was shifted to this alloy and to malleable nickel. It was obvious that this could not be pursued without proper laboratory facilities.

Accordingly, in 1906, I was engaged to equip and to operate the company's first research laboratory at the Orford Works. There the work was almost exclusively related to the Monel alloy until the Development and Research Department was established in 1922 to attack the larger problem of increasing the use of nickel by gaining, and especially by disseminating, the knowledge which would make its extended use possible.

Drawn entirely from personnel of the closed Orford Works, the new department was housed in two small rooms adjoining Stanley's office in New York City. In charge was A. J. Wadhams who had been General Superintendent at the Orford Works. Somewhat illogically, because in 1922 nickel consumption had almost disappeared, the Development and Research Department was not set up for purposes directly associated with sales. Inco had a Nickel Sales Department as well as a Monel Sales Department.

The new department was an engineering and technical department. It was given the direct responsibility of maintaining effective field relationships with users and producers of nickel products, steels and alloys for the purpose of educating industry to a wider and more diversified utilization of nickel products and of nickel itself. Also, it was invested with the responsibility of developing new and useful products. Although the department would make no actual sales to the trade, it was hoped that its activity would result in a greater inflow of orders to producers of products

containing nickel, which in turn would result in an increased demand for the metal.

In naming Wadhams, Stanley chose well. A graduate of Annapolis, Wadhams had a clear vision of what could be accomplished by a properly staffed Development and Research Department. His vision was that there could be built a really large use for nickel in a broad sense rather than in the restricted sense of armament. He put this into effect by going out and hiring competent men for this work. Thus, was built the new building on the foundations which have always underlain our research and development activities.

The basic principles have remained the same: One, gather information on the properties, methods of manufacture and uses of any product containing nickel. Two, have a crew of competent technical men located geographically in selected spots ready to assist the consumers or potential consumers. Three, work steadily in the laboratories to develop further information. Four, disseminate all pertinent information as widely as possible.

You will note the selection of the word "disseminate." No one company has the means or ability to utilize or develop all the information on a subject like nickel; and it is fortunate that this is so. Technical progress comes from many men, each working on some subject dear to his heart dictated by scientific zeal or by the demands of some commercial problem. By the sowing of the seed of accurate technical information to the largest possible number of scientific and technical workers, many a new idea is born or wished-for result achieved.

j. f. t.

IN the prospecting days of Rinaldo McConnell a good deal of exploring could be done with no equipment but a geologist's hammer, a compass, a heavy jackknife, some matches and a canoe. The same thing was true of the prospecting days of inventors such as Thomas Alva Edison and James Watt. A good deal of exploring was done along scientific frontiers by the use of a few acids, a furnace, some test tubes — and observation.

Instead of a geologist's hammer, a compass, a heavy jackknife, some matches and a canoe, prospectors along today's geological frontiers ride airplanes and helicopters, carrying magnetometers, geiger counters and all sorts of recording devices to find what lies hidden in and on the earth. . . .

Instead of a few acids, a furnace, and some test tubes, postriders along today's scientific frontiers use equipment and facilities as complex as the areas in which they search, whether the areas are in the nucleus of the atom, in the infinitude of outer space, into the secrets of transmutation of the elements, or into the microstructural changes which take place when metals are subjected to high temperatures.

There is a device called the electron microscope. Instead of a beam of light, it uses a beam of electrons. By using a beam of electrons it is possible to resolve details as elusive as *40-billionths* of an inch in diameter whereas, when using a beam of visible light, the limit of identification is about *16-millionths* of an inch. If a photograph is made using an electron microscope, and the photograph is enlarged, a useful magnification of 500,000 times can be achieved. At this magnification, a human hair would have the outlines of a tree trunk eighty feet in diameter.

The electron microprobe is another device. With it, the chemical composition of a spot on a piece of metal — a spot as infinitesimal as 40-millionths of an inch in diameter — is disclosed. By comparing one such spot with a similar spot 100-millionths of an inch away, the scientist often is able to determine the thermal history of a piece of metal. The microscopic cause of the cracking of a large chemical reactor was identified in this manner.

It is questionable if today's needs could be met by yesterday's methods and yesterday's tools — and as with today, so with tomorrow's needs and tomorrow's tools.

Nickel is a member of the group in the periodic table which is called the transition group of elements. Eight of the fourteen elements recovered from the Sudbury ores are members of this transition group. Such tremendously important elements as iron, cobalt and platinum as well as palladium, rhodium, ruthenium and iridium are among them.

The whole group has properties which, in combination, are unique when compared with the rest of the more than one hundred elements known. For illustration, it is only in this group that elements are found that are magnetic. This magnetism is related to the atomic structure of the transition elements.

They resemble each other in the outer layers of electrons in that the next to the last, or penultimate, layer has vacancies in it, and it is the ability of electrons to take up positions, under some conditions, in the second shell that gives the transition elements such unique properties as high catalytic activity in addition to magnetism.

Nature has been generous in the atomic structure of nickel itself, as well as in its distribution of some of the elements found with the metal. It is a generosity that was beginning to be seen in 1922 when the Development and Research Department was established. However, the company's research efforts began before 1922. The foundations were shaped in the years from 1902 to 1922; but, years before 1902, inquisitive minds were investigating and experimenting with nickel.

Late in the 1860's, Joseph Wharton was trying to produce nickel in malleable form, workable in the same way iron was workable. In 1872, he produced a malleable nickel by "removing," as he wrote in 1904, "the oxygen from the fluid nickel by the use of carbon," and sent samples of his handicraft to an exhibition in Vienna. Here the samples were examined by Theodor Fleitmann, who was to become an important factor in the nickel industry in Germany.

Doubting that oxygen was the sole cause of the difficulties encountered in producing malleable nickel, Fleitmann began his own experiments. He introduced metallic magnesium into the molten nickel. The results were good. Elated over them, but cautious, nevertheless, Fleitmann kept on with his experiments and satisfied himself that the major cause of the trouble was not the presence of oxygen in the fluid nickel.

Mixing one part magnesium with 200 parts of melted metal, Fleitmann produced malleable nickel which was much superior to Wharton's product. In 1878, he obtained German Patent No. 6365 covering his process and in 1879 United States Patent No. 217,523. It wasn't until the early nineteen-twenties that Merica became curious enough to ascertain that sulfur alone is responsible for the nonmalleability of nickel. Through his studies, he

was able to explain the workings of the brilliantly successful Fleitmann method.

There were a good many investigators into the properties of nickel — the list is long. For the most part metallurgy, as it was practised, was an art and not a science. Largely, the early practitioners did not really understand the chemistry, or the physics, of a particular process; nor, did they have the tools of later years.

But they were aware of certain established phenomena, and through this awareness they developed processes. Interestingly enough, many ideas which earlier investigators were forced to abandon were found to be practical with the introduction of new tools. The changes that have come in reducing ores to usable wealth have been extensive.

Research has ceased to be a one-man pursuit. Now a team operation, it not only raises the level of inquiry by finding new knowledge but also finds the way to apply the same new knowledge. The dream of the medieval alchemist was to change base metals into gold; the modern alchemist does change them and in so doing brings a value greater than gold.

There is an alloy of iron, nickel, chromium and titanium which was developed in one of Inco's research laboratories. A 17-pound ingot will produce about four pounds of finished strip from which 150,000 to 250,000 hairsprings (depending upon their size) can be made. At a price of one dollar a spring, this figures out to an alloy value of approximately $50,000 a pound, or about one hundred times the price of gold.

Another example is provided by the magnetic alloys used in strip form for memory cores in computation and similar electronic devices. A 78% nickel, 4%

molybdenum and 18% iron alloy is rolled into strip 1/8th of a thousandth of an inch thick. In this form the alloy sells for $2,000,000 a ton, or about twice the price of gold. In each case, the value of the base metals is less than one dollar a pound.

There are a number of things that make these base metal alloys command a price several times that of precious metals. There is the precise compounding and melting of the basic alloys; there is the careful processing of the ingot through the several stages of forging, hot and cold rolling, with intermediate annealings until the desired thin, narrow strip has been produced; there are the inspection tests to qualify the material for its intended use and, finally, there is the heat treatment that achieves the last precise adjustment of the essential properties upon which the alloy depends, and by which its relatively high cost is justified.

These various steps are typical of the manufacture and processing of many of the materials that are creating the alloy age. Naturally, most alloys are used in more massive forms than hairsprings, and sell for much less money per pound, but all depend upon the knowledge of the metallurgists who devise and melt them, the experience and special equipment of those who cast them in precise forms, or who forge and roll them into usable forms, and the skills of those who convert them into vital components of electronic devices, jet engines, rockets, nuclear reactors, or any other application.

In the years immediately following World War I, important business was being lost because of the failure of Monel nickel-copper alloy to stand up under conditions where, in theory, it should have performed well.

They were conditions such as existed in steel plants where wooden pickling tanks were held together by Monel alloy tie rods. The rods, when completely immersed in sulfuric acid, seemed to be almost indestructible but, when used in places where the acid merely spilled on them, they corroded — destructively! — within a few weeks.

Word went through the steel industry that Monel alloy was not dependable, and so much business was lost that consideration was given to the suggestion of discontinuing the promotion of the product for such applications. Before doing so, however, Robert J. McKay, the young chemist who came to the company in 1916 to help in solving the problem of smoke control in Sudbury and in Bayonne, was sent to the Mellon Institute of Industrial Research, in Pittsburgh, to see if he could find a remedy.

Arriving in Pittsburgh in August 1920, McKay was under instructions to conduct laboratory studies and he became so interested in them that he neglected the second part of his instructions, which was to visit plants where Monel pickling rods were still in use and report to New York how they were behaving. He was reminded of his negligence, but not at the moment.

At the moment he was conducting corrosion tests the results of which were so unbelievably consistent that one of his superiors in New York wrote to him, saying, "You're kidding yourself, or are you trying to kid me — because neither you, nor anyone else, can get results that are so close together in corrosion tests." With unbelievers watching, McKay duplicated the results and, in advance of the experiments, said what he would get under certain conditions, which he named. Under other conditions which, also, he named, he said there would be a variance of fifteen per cent, or more, in the percentage of corrosion.

He was able to make his predictions because, not long after beginning his experiments in Pittsburgh, he forgot to close the laboratory windows at the close of a working day. The following morning tests revealed an unusually high corrosion rate. This was something that needed to be investigated. McKay tied it down, and concluded that the cause of the high rate of corrosion was oxygen.

He began studying what air would do when introduced directly into a given concentration of sulfuric acid, and learned that full aeration would give about six or seven times the corrosion rate normally obtained without any artificial aerating apparatus.

Making test, after test, after test, he found that by blowing away the steam from the top of the pickle bath he could produce high corrosion results. Another thing he found was that the copper content of the pickling vats seriously affected the corrosion results. Out of the many tests came the realization that copper accelerated corrosion, and accelerated it best when it was concentrated in one place — and strangely the place where there was the least copper was the place where there was the most rapid corrosion.

Beginning to be clear to McKay were two things that accelerated corrosion — oxygen and copper. The chemistry between the two was quite different, but the result was the same. What could be done with oxygen could be done with copper — a cell could be produced which corroded rapidly, and the place where corrosion occurred was the place where there was the least amount of oxygen or the least amount of copper, provided there were greater concentrations elsewhere.

All tests led in the same direction. At the end of the road was a concentration cell. This discovery by McKay introduced a factor not previously considered in any corrosion problem — the possibility of there being a concentration cell present in the form of an oxygen concentration cell, or a concentration cell of some metallic element, such as copper.

In 1921 the idea seemed so new that the company delayed issuing any statements because, as one of the research people ironically observed, "the data supporting the discovery was not useful because it did not agree with common knowledge." And yet, a hundred years previously Faraday had recognized that dissolved oxygen could produce an electric current.

McKay wrote a number of papers that, afterwards, were published in technical publications and, in 1936, collaborated with his assistant, Robert Worthington, in writing *Corrosion Resistance of Metals and Alloys*,* which soon became a standard reference work in the literature of corrosion.

Satisfied that the solution to the problem of corroding pickle rods was near, McKay responded to the second part of his instructions and began visiting plants where Monel alloy pickling rods were in use, and reported his findings to New York. Already McKay had observed that at joints between timbers in the pickling vats the Monel alloy tie rod, which fitted quite snugly through a hole in the timbers, was subject to a crosswise flow. This slight leak washed away the dissolved copper from previous slight corrosion which was concentrated along all the rest of the rod. That made the place near the joint, where there was an acid leak, the anode of a cell while the rest of the rod

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served as a cathode. As a result, the rod would neck down and break at the point where the slight flow of acid washed away the dissolved copper from previous slight corrosion.

Copper was not present in the main bath where the pickling was going on because it was removed by a chemical reaction called cementation on the steel that was present. In the main bath corrosion was slight, but in the side structure of the tank where copper was present, it made a cathode of the Monel rod excepting where it was in contact with copper-free acid. As a result, the spot on the rod where copper was not present became anodic and, in so doing, became the spot where rapid corrosion took place.

McKay's suspicions regarding the mechanism of corrosion of the Monel rod led to his discovery of the oxygen concentration cell. In an inverted sense, chemically, he saw that whatever happened with the copper cell happened with the oxygen cell — this being that, while oxygen accelerated corrosion on steel, most of this same corrosion occurred at the place where oxygen was least concentrated.

This concentration cell discovery by McKay introduced a factor which, ever since, has had to be considered in any corrosion problem, the question being the possible presence of a concentration cell.

Many of such problems have been solved but many other problems remain. In fact, so many remain that losses from corrosion reach an estimated $5,000,000,000 annually. One cause may be found in the material itself. Others come from environments such as temperature and atmospheric conditions. There are the complications with respect to the concentration of dissolved gases, especially

oxygen. There are all sorts of causes. Also, some of the loss comes from the practice of using vulnerable materials because it is felt it is not justifiable to use more durable but more expensive materials.

As far back as 1907 inquisitive minds were experimenting into the causes of corrosion by suspending specimens of metal in the brackish waters of the Kill van Kull which ran by the company's plant in Bayonne. From these crude beginnings the marine exposure facilities were moved to various points along the Atlantic coast north of Atlantic City. Small rafts were anchored close to shore and from the rafts were suspended samples of metals and alloys. The operation was never satisfactory, and was abandoned in 1935 in favor of Kure Beach, near Wilmington, North Carolina.

In that same year Francis L. LaQue, now Vice President in charge of Development and Research activities, but then a member of the staff, was in the plant of the Ethyl Dow Chemical Company at Kure Beach in an advisory capacity on a corrosion problem that was troubling the chemical company. Recognizing the suitability of the location as a salt-water testing station, LaQue suggested the idea. The response was immediate. A program was put into operation a few weeks later. It was a program that was under the supervision of the Nickel Company.

In 1941, additional land was obtained so specimens could be exposed to atmospheric corrosion, in addition to corrosion by sea water. In 1949, and because of the inconvenience of the need for frequent dredging at Kure Beach, a new site for sea-water immersion tests was acquired on Harbor Island, a few miles to the north. On this site were built extensive facilities, including laboratories and shops. Atmospheric tests continue to be made at Kure Beach.

Tens of thousands of specimens of materials are constantly undergoing sea-water and atmospheric tests to determine their resistance to corrosion. They are tests that include all metals and alloys, wood, plastics, fibers, ropes and protective coatings of all kinds. The doors to the facilities are kept open not for just one company but to many companies so that all problems in marine corrosion may come under general scrutiny.

A great many things have been learned about corrosion; a great many things remain to be learned.

For years one of the most tantalizing questions in research was "Why can't we make alloys having a strength of a million psi?"* Aggravating the situation was an inclination on the part of more than one metallurgist to accept the belief that the ceiling in tensile strength was around 350,000 psi although, theoretically, the strength of metals such as nickel (it is strength that is calculated from the cohesion of the atom) is more than a million pounds per square inch. Infinitesimally small defects called dislocations and vacancies in the crystal lattice of the atoms have prevented the metals from living up to their theoretical strength — or, so it has been argued.

Turning their eyes away from the bulk physical properties of the metals, researchers began studying metals from the inside out. It was a new approach, and one that had been defined by a professor at the Massachusetts Institute of Technology, as "molecular engineering." Through the development of special instruments such as the electron microscope, scientists have

*Pounds per square inch.

been able to study the inner structure of metals, learn about defects that previously were submicroscopic in size and have concluded that if a metal were to be strengthened it would have to be done by dealing with the dislocations and vacancies.

A similar approach led to the discovery of the transistor at the Bell Laboratories. Looking at semi-conductors like silicon and germanium from inside out, the scientists discovered that their desired electrical behavior could not be achieved in a pure crystal. The property desired was governed by certain impurities which exerted a tremendously useful effect when present in extremely minute amounts. At Inco, the same techniques have been applied to nickel plating.

The electron microscope has been employed to examine differences in the structural details of nickel plating that influence its brilliance and protective qualities. Other instruments have been used to study its electrochemical behavior in relation to the steel or zinc on which nickel is plated for beauty and protection and to the chromium with which nickel is associated for such purposes. This is providing the basis for continued improvements in the performance of nickel as plating.

As mentioned previously, the growing concern with minute differences in composition and structure made possible by new tools and new concepts is accelerating progress toward the goal of the theoretically achievable properties of alloys.

On such a basis of advance in the abilities of alloys to withstand extremes of stress, temperature and other environmental factors, old "barriers" such as the sound barrier in the flight of aircraft and the "thermal thicket" in the flight of vehicles destined for outer space have been surmounted.

In 1939, on the first day of September, military might was heralded as the prophecy of a new order that would endure for a thousand years. The year of 1940 was scarcely half over when British and French soldiers, more than 300,000 of them, crowded the beaches and the Channel waters off Dunkirk waiting rescue from the hurricane of steel that had cut a swath across western Europe. By day and by night Hitler's bombers swept over England spreading destruction.

Without delay, the supply sources established by industry in years of peace became the major elements of Britain's material power. Urgently, the Air Ministry called upon the Mond Company to develop an alloy that would stand up under stresses above any hitherto encountered – namely, an alloy for use in gas turbines and jet-propulsion engines.

Within a year, and after producing more than 1,000 experimental alloys, the Mond Research Staff had two which, in the careful words of the scientists, had "interesting possibilities."

Basically, each alloy was of the 80/20 nickel-chromium type, with titanium added for stiffening purposes. One alloy, trademarked Nimonic 75, was much stronger when subjected to higher temperatures than the basic alloy; further development brought a second alloy, trademarked Nimonic 80, which had a greatly increased strength. It was a strength which made it particularly suitable as a material for the rotor blades of jet engines.

Promising as the alloys appeared to be, there remained the problem of solving the difficulties of large-scale

production of materials that, in spite of their great strength at high temperatures, had to be worked at such temperatures. The equipment, skills and experience of Henry Wiggin & Company, Limited, were drawn upon by Mond and by the British Air Ministry. As a result, British jet aircraft were in the air in time to meet the onslaught of flying bombs in 1944.

In the years since, the two alloys have proved invaluable. In these same years the turbine rotor blades of every British jet or turbo-prop engine have been made from the two Nimonic alloys and their successors. Nickel remains the dominant element in alloys that, increasingly, must be capable of serving at higher, and still higher, temperatures.

To nickel, in addition to chromium and titanium, have been added cobalt, aluminum and molybdenum. The research continues in the same laboratories that supplied the first of the alloys that made possible gas turbines and jet-propelled planes.

Not so exciting, but nevertheless important, has been the breaching of other barriers.

During World War II chromium was in such short supply that researchers in the Bayonne Laboratory began looking for a suitable substitute to use as a "whitener" in Ni-Hard abrasion-resisting cast iron, a chilled iron containing nickel and chromium which was used extensively in articles where resistance to wear and abrasion of the highest order was needed. In the course of investigation along these lines, it was found that magnesium had a most unexpected and amazing effect upon the structure of cast iron to which it was added.

Magnesium, when added in appropriate amounts and under particular conditions, transformed the graphite in cast iron from a normal flake form to the form of spheroids.

This was a profound structural change that carried with it major improvements of mechanical properties. The resulting iron with spheroidal graphite structure could be directly cast in ductile condition without the heat treatment which was necessary with malleable iron. Major increases in strength also could be developed in magnesium-treated ductile iron, together with many other engineering advantages.

Although nickel could be used advantageously in the production of the material and as a carrier for the introduction of magnesium into iron, it was not necessary, metallurgically speaking. *This was a new metal;* and it was a product of such great potential value that it was decided to proceed with its industrial development. This decision was made in order to provide for the orderly solution of the metallurgical problems that, it was recognized, would be encountered in adapting it to industrial uses.

The product, called Ductile Iron, is now a prominent member of the family of cast irons.

Up to the time of the real opening of the Frood mine in the late nineteen-twenties, compilation and distribution of information concerning platinum metals and their alloys had not been fully organized. Hand in hand with the small amount of available information was the small volume of platinum metals in use. With the Frood deposit being opened it became clear there would be a substantial increase in the production of the metals.

Recognized as a world authority in the field of

platinum metals was Charles Engelhard, President of Baker & Company, chief unit in a world group* which had been engaged in the refining, fabrication and distribution of the platinum metals for many years. With headquarters in Newark, New Jersey, Baker, for years, had purchased and consumed, or resold, the platinum metals produced by Inco and by Mond.

With the Inco-Mond consolidation, and especially with pressure from the largely increased amount of platinum metals coming on what was a very limited market, it was apparent that all possible means must be used to relieve the pressure which already had driven the price of platinum to a low level.

Promptly, Inco turned to its experience in widening the markets for nickel and copper. It began intensive research into the platinum metals; also, it began gathering and distributing information of a technical nature to all interested users of the metals, whether actual or potential users. In Bayonne, Edmund M. Wise and his associates began important research into the properties of the so-called precipitation-hardenable palladium and platinum alloys, particularly the former.

As a result of their work it became possible to develop compositions principally of palladium, palladium-silver and palladium-silver-copper with exceptionally high and favorable mechanical properties for dentures and other dental constructions. Also, they carried their research into improvements in the casting properties of palladium which, up to this time, could not compete with platinum in the ease with which it could be fabricated into jewelry.

In Newark, Baker, already the world's largest producer of platinum mountings for the jewelry trade, began

*Organized as Engelhard Industries, Inc., in 1958.

active work on developments which led among many things to the platinum spinneret for artificial fibers, to platinum bushings and other equipment for handling molten glass and, later, to the development of platinum catalysts in the spectacular expansion in the field of high-octane gasoline through the platinum reforming process.

Increasingly, and as the result of research by Engelhard's organization, in the Inco-Mond laboratories, and by users, the use of platinum has become important in industrial plants where there is need for specialized alloys, particularly alloy products having very superior physical and chemical properties.

In 1930, the world production of platinum metals was about 290,000 ounces; in 1960, the world's production of platinum metals was about 1,000,000 ounces. In 1930, about 85% of Inco-Mond platinum metals was fabricated for nonindustrial purposes; in 1960, about 85% of the Inco-Mond platinum metals was fabricated for industrial uses.

In its way, one of the best things that ever happened to International Nickel was the loss of the major part of its business as the result of the Washington Disarmament Conference in 1921-22. The market that was wiped out was military.

To make up for the loss of armaments and military undertakings, gun forgings and armor plate, the company gathered together all its creative faculties in commercial and industrial research, sales development, advertising, merchandising, marketing and distribution, in field service and in management — and turned them loose, all at the same time, in an organized effort to fully develop a

market sufficient to satisfy its already developed production.

Fifteen years had passed since the Disarmament Conference and, largely as the result of the organized effort, the sales of nickel had grown from 12,804,000 pounds in 1922 (the first year of disarmament) to 207,700,000 pounds in 1937.

Civilian uses had multiplied, the result of the development of new alloys and other nickel applications. Multiplied with them were production problems. Becoming more and more urgent was the need to find ways to offset the falling nickel and copper contents of the Sudbury ores, as well as higher labor and supply costs. A natural place to look was in the research laboratory. Accordingly, in 1937, a laboratory was built in the shadow of the reduction works at Copper Cliff. In charge, as Director, was J. Roy Gordon.

Since coming with the company in 1936, Gordon had pondered over the mystery of pieces of rock in which nature had sealed nickel and copper, gold, silver, cobalt, iron, platinum and a clique of other metals. Realizing that the company would never fully develop its resources until it was able to extract, profitably, not only every penny's worth of nickel, but every penny's worth of every other element locked up in the ore, Gordon had fretted over how, for decades, nickel and other elements had been lost in fumes or thrown away on the dump as slag.

Typical of his reaction to such losses was his comment upon seeing a photograph high-lighting the dramatic beauty of smelter smoke drifting from one of the high stacks at Copper Cliff: "What a waste of sulfur!"

The thought or words were not new. Probably every company metallurgist, beginning with Henry M. Howe, had made the same observation. Gordon's comment is remembered because he was there to do something about it, and did.

However, increased recovery of products from the ore was not alone as a problem. Equally pressing was the matter of operating costs. Looking over various processes awaiting improvement, Gordon decided that the Orford Process for separation of copper and nickel offered one of the best opportunities for savings. Under his leadership investigators in the Copper Cliff laboratory began tracking down clues. Within months, they began putting a saddle on what appeared to be the right horse. It did not stay there.

Through half a century the molten copper-nickel matte had been cast and then resmelted in two stages with sodium sulfide to remove the copper. This was the famous "tops-and-bottoms" result of the Orford Process. Now, in 1938 at Copper Cliff, instead of being cast and resmelted, the molten matte, as produced in the Bessemer converters, was simply mixed (in the first stage) with sodium sulfide and its heat was found to be sufficient to obtain the desired reaction. To some extent a similar arrangement was possible in the second stage.

It was the first major improvement in the Orford Process in fifty years. Costs of the process were cut almost in half but, in 1943, the appearance of a radically new process for copper-nickel separation put a stop to the Orford Process. The radically new process was one that had been in embryo for many years.

It had been known for a long time that solidified copper-nickel mattes were composed of grains of different compositions. As early as 1892, David H. Browne, at

Copper Cliff, published a note on the occurrence of iron-nickel crystals in copper-nickel-iron matte. Heat treated matte was separated into high and low sulfur fractions at the Bayonne laboratory in 1919. By 1932, the flotation process had been advanced to the point where it was being used to separate copper and nickel minerals in the Sudbury ores. Unsuccessful efforts then were made to obtain a separation of the metals by slowly solidifying the matte from the molten state before flotation. No worthwhile separation was obtained at that time.

In March 1938, research people at Copper Cliff began concentrating on what Gordon believed was the most promising clue to the two problems created by the falling nickel and copper contents of the Sudbury ores, as well as the rising labor and supply costs. The clue was in the results of the slow solidification of the Bessemer matte from the molten state.

After a long procession of experiments and the introduction of new equipment, the first satisfactory separation of copper and nickel was obtained. By 1943 successful operations were being carried out in a pilot plant on a tonnage basis.

In the process, Gordon obtained not only savings in costs but found a way to separate platinum and other precious metals from the bulk of the nickel. The small proportion of copper-nickel metallic alloy present in the matte was found to contain most of the precious metals.

The metallic fraction was easily separated (magnetically) from the finely ground matte. There was an improved recovery of precious metals, previously lost. Also, since the nickel sulfide was low in both copper and precious metals, it became evident that one could sinter part of it for direct production and sale as nickel oxide sinter, without the previously required refining operations. Development proceeded along these lines so that by 1946 the company was able to offer this additional product. It met with immediate acceptance.

The over-all process consists in slowly cooling the nickel-copper converter matte from the molten state almost to room temperature, using molds holding about twenty-five tons. This cooling yields a relatively coarse structure of three constituents: Nickel sulfide, copper sulfide and a small amount of nickel-copper alloy containing the precious metals. The cooled matte is crushed, finely ground, and treated by flotation and magnetic separation to part the three constituents. Each fraction is then processed to the final products by more or less conventional methods.

Carle R. Hayward, professor of metallurgy at Massachusetts Institute of Technology, who made the original determination of the copper sulfide-nickel sulfide phase diagram in 1914, wrote in the *Engineering and Mining Journal* in February 1948, and described the new process as "one of the most fascinating metallurgical developments which has appeared in many years . . . the patents have specific application to the nickel industry in the Sudbury district, but they are intriguing in their use of fundamental science. Some of our ore deposits containing finely divided mixed sulfides were probably formed in the same way, and here nature's laws are being used to separate sulfides produced in the smelting operation. . . ."

Nor, along the way, was the matter of sulfur overlooked. Oxygen flash smelting of copper concentrate provided a further step in saving sulfur; and, if one name must be named in this connection, it is Gordon.

Day and night slag trains continued to run until the time came at Copper Cliff in 1954 when the people working in a pilot plant and in the Research Laboratory were called together and were told of the importance of what they were doing, and the contribution they were all making, by Paul Queneau, Technical Assistant to the President, who was directing the work. In effect, he said:

"You are building an iron plant. Very soon, instead of just seeing slag trains running to the dump heaps, you will be seeing trains loaded with iron ore rolling out and starting on their way to market."

Begun early in 1956 was the commercial recovery of iron from the ore.

As an oxide in pellet form, it is a premium product and, being 68% iron, 1% silica, is believed to be the highest quality iron ore produced in quantity in North America. Solution to the problem of recovering this exceptional product from the Sudbury ores was achieved by separating an iron concentrate of low nickel and sulfur content with the virtual elimination of copper, precious metals and silicates.

Inevitably when research work is conducted by creative and imaginative people the list of accomplishments is impressive. That is true of all well-staffed research laboratories, including the laboratories of International Nickel. More surely than treaties between nations, the work of creative and imaginative minds shows the direction in which the world is moving. Affirmed by natural law, it is a future that has promise, and a promise that has assurance.

All these steps in processing impose their demands upon metallurgists for new information and new applications of old information; demands upon management and capital for new tools to meet and process more refractory materials to higher standards of quality and performance; demands upon labor for more skills and greater care in the handling of alloys that may be difficult to work; demands upon fabricators to ensure that what is turned over to them is not spoiled in fashioning and assembling the finished parts; and, demands upon the designers to make sure that they properly define their needs and that they use materials so as not to be wasteful of alloying elements or of labor.

While metallurgists know quite a bit about why materials behave as they do, why one alloy is stronger, or more ductile, than another, or why one constituent has one effect and another constituent quite a different effect, the need is for more fundamental information all along the line. Presently, new compositions and heat treatments follow pretty much in the pattern of the empirical type of investigation. The real demand is for more basic studies. Further progress will require increasingly greater advances into metallurgy.

And, speaking of the need for more basic studies, it may be said that the metallurgist — as with all scientists — must go on with his work of finding new knowledge in the full realization that his search will never end. That is his destiny — and yet, in the full realization of his destiny lies his deepest understanding.

For no research is ever really ended. Each new process is but a breathing spell along the road; and any description of a process is only a history of this breathing spell. The success of research is best measured by the shortness of the space of time between the discovery of

one process and the development of a new one which makes the other obsolete.

The discovery and application of new techniques of recovering nickel and the other elements contained in the company's ores is moving at an accelerating rate.

19

Recorded Conversations

FROM the recordings:

B. I know your name is John Fairfield Thompson, that you were born in Maine and brought up in Brooklyn at a time when Brooklyn was not a part of the City of New York, but I am curious about all three of those things. Where, in Maine, were you born?

T. Portland.

B. How did you happen to be named John Fairfield?

T. It was not a happenstance. John Fairfield was my father's closest friend. I was named after him.

B. Did your family have any roots in Brooklyn? I mean, did they have any particular reason for moving there from Maine?

T. Yes. My grandfather, that is my mother's father, was a newspaperman, and he came to Brooklyn when

Horace Greeley started the New York *Tribune* which, later, was merged with the New York *Herald*. My grandfather was financial editor of the *Tribune*. That would be somewhere about 1840 or 1841.

B. Do you think of yourself as a Downeaster, or as a New Yorker?

T. Both, but essentially, I guess, as a Downeaster; and certainly as a man brought up in the New England tradition.

B. Go to church?

T. I am a Unitarian. I married a Unitarian, whose father and mother were married in the same church, and by the same minister, as my father and mother.

B. In Maine?

T. In Brooklyn.

B. Do you suppose you would be a Unitarian if you had not been born into it?

T. That's a question I can't answer. But I think so. Of course, I am saying this from a very notional point of view; or "prejudiced" may be a better word. It is a church to which anyone can belong without having his beliefs forced into a mould. As a Unitarian I do not have to subscribe to any creed but am free to have my own beliefs and to keep or change them as I grow in experience or knowledge.

Fundamental to this is the importance of the individual and the obligation of each individual to stand on his own feet, make his own decisions and take the responsibility for these decisions. He should carry his own troubles and, if strong enough, help other people to carry theirs.

B. Emerson expressed his Unitarianism in different words having much the same meaning, pointing out in his essay "Self Reliance," I think it was, that "nothing is . . . sacred but the integrity of the mind," and in another essay, I have forgotten which, saying "I have learned that I cannot dispose of another people's facts; but I possess such a key to my own as persuades me, against their denials, that they also have a key to theirs."*

This is Thompson:

There is only one way a company, large or small, should be run. The people sitting around a table should sit there as equals. At the end of the discussion, the man who is carrying the biggest load, and on whose shoulders the responsibility ultimately rests, should review what has been said and whether general agreement has been reached. If not, then he has the right to make the decision; and having given it, is entitled to the unqualified support of everybody.

The present history of any progressive industrial operation is the history of a continuing race between technical improvements and rising costs, especially higher wage rates and higher taxes which appear to be an outstanding characteristic of recent years. Processes cannot be improved and costs lessened at the same speed as wages and taxes can be increased.

Before any major change in process can be introduced there must be a comparatively long period covering laboratory studies and pilot plant testing. Then the construction of a plant and the installation of equipment to utilize the process and, finally, the starting of the

*From the essay "Experience."

operation on a commercial scale. One of today's most pressing problems is to bring these two elements — technical improvements and rising wages and taxes — into better synchronization.

For more than half a century we have devoted time and effort to the search for new applications for our various metals. It is to be hoped that other producers and those newly coming into the field will feel as we do, that being in any metal business carries with it the responsibility for developing and expanding the market for these same metals.

One of the advantages of working for a large corporation is that it offers so many different kinds of opportunities. There is room for specialists of all sorts. In its fold men can live the lives that suit them and yet feel themselves part of a creative whole. And there is room for the non-specialist or rather for the man who specializes in all branches rather than in one branch of the industry.

B. Among your people there are those who say that, in your own right, you are a real good window shopper. Are you?

T. I don't know how good they make me out to be, but I do like to see how merchandise is displayed in store windows, and in the stores themselves. I suppose I got the habit by spending evenings walking around to see how different merchants were displaying platinum and palladium jewelry.

Once interested in windows, I became interested in the entire subject of jewelry display until now it is almost second nature for me to look at nearly every kind of store, and wonder why the merchant puts some things in some places, and other things in other places. If you go inside and ask questions, usually you will find that things are displayed as they are for very good reasons.

It's something like when a person goes abroad for the first time. The whole thing seems mad — the many things the people do that you don't like, or they do not do that you wish they would. You will learn, if you are open-minded, that things are done the way they are done because it is the way developed by experience. It is always a remembered first experience, especially in England, where the language is the same.

That is why I always say to the young people who come over from England to work for a year, "Now that you are on this side of the ocean, don't be fooled by the language. Just imagine you are working in Afghanistan, and not in the United States. Approach the United States as if you were going into Afghanistan, and study why things are done as they are done, and why the natives think and act as they do.

"You will find a pretty good reason for the habits, and customs, that prevail wherever you are — in the United States, in Canada, in England, or in Afghanistan. Not only that, but you will get along much better, and go home much wiser."

B. In the Ontario town where I spent part of my boyhood — it was a small town called Picton — there was a canning factory where most of the kids got jobs in summer vacations. The pay was small, and the hours were long — ten hours a day, six days a week. I have

been thinking about those days, and thinking about them started me wondering about the length of the work week when you started with the Nickel Company.

T. The work week for everybody on shift was eighty-four hours. We worked ten-hour days one week, fourteen-hour nights the next week and, to accomplish the shift changes, twenty-four hours one Sunday, with twenty-four hours off the following Sunday. That was a working schedule that had been in existence for many years in the metal industry.

B. In other words, the length of the workday varied, depending upon the shift, although the length of the workweek was the same?

T. That's right. The hours were entirely too long, and were recognized as being too long. They came to an end by stages. Before 1917, at the Orford Works, in Bayonne, where I was employed, we shifted to an eight-hour day, three-shift operation.

B. How were the wage rates established?

T. Wage rates were set up by comparison with the rates paid by other companies in the district. The practice of the good companies was to pay somewhat more than the going rate so people would be attracted.

For the most part, men expected to spend their lives working for the one company. They expected to be paid more than the going rate, just as they expected to have their wages raised as conditions changed.

B. What about strikes?

T. Never had them. The company was small. Everybody knew everybody else.

Much later, or in the nineteen-thirties when a slew of government agencies was set up in Washington, a wave of organizing swept across the United States. As one who had been associated with industry nearly all his life, I felt, as I think most persons in industry felt, that the time had come for a change — that the time was at hand for organized labor to play its fair part in business.

I really welcomed the opportunity, now that it was here, of sitting down with labor to discuss our first contract. The first talks were disappointing. The union representatives would not negotiate a labor contract as one would negotiate any other kind of a contract. Instead, they injected an emotional spirit into the discussions, and steamed up the men they were supposed to represent into a frame of mind that made it difficult to talk over contract matters in a calm and proper way. The first effort was to get us to sign a contract exactly the same as was signed in the steel industry.

We were an entirely different business, although in the Huntington mill many of the operations, and much of the equipment, were the same as used in the steel mills. We refused. Ours was a different metal. It was worked under different conditions, and in different ways. We brought these points forward in our discussions. Finally, the difference was recognized, and a contract was signed. It was a negotiated contract, and not a contract pushed across a desk by a union leader, and signed without any meeting of minds as to terms, as were some of the contracts signed by metal companies in that period.

I have always felt that negotiated contracts are the only kind of contracts one should have. There should be recognition by management that employees have

every right to organize, and that the right to organize includes the right to bargain as to hours of work, terms of employment, wages, and so forth.

The main thing is to make sure that the men and the company agree on what is a fair wage scale, what are fair hours, what are fair working conditions — and these things should be arrived at by agreement, and not forced down the throats of the people on one side, or the other.

In the early days of the National Labor Relations Board a great opportunity was missed to advance labor relations in the United States. Instead of approaching the subject in a calm and dispassionate manner (as an agency of government should) Board members approached disputed points in much the same emotional manner that characterized union leaders. Frequently the Board acted as if it had already made its decision, and adjusted the arguments so it could announce a finding that had some appearance of logic.

This introduced a false note into all labor negotiations; also, it introduced a false note into the work of the National Labor Relations Board itself.

The day must come, and the day will come, when union representatives and company representatives will acknowledge the existence of an overriding interest that is greater than the interest of any private group. That overriding interest is the public interest.

In the day that must come there will be a fair facing of the problem by both sides, and both sides will arrive at a fair contract which each is willing to sign. In negotiations where the public interest is the dominating interest everybody comes out all right.

Thompson again:

Metallurgy and research are simply the means for revealing and employing the latent worth possessed by nickel — a metal which, in many instances, does what no other metal can do.

The history of Sudbury is the history of nearly all mining districts. Mines were discovered, smelters built and venturesome pioneers risked and lost their money producing a product which, when it was ready for sale, had to be offered to an almost nonexistent market.

It has required a great deal of time, effort and money to bring what once was considered a worthless metal to its present status.

We live in an age of white metals, and I believe that our own Monel nickel-copper alloys have been a major factor in establishing this age.

Great changes have come and with the coming the world has amassed enormous debts. It is evident that we all must work harder, and longer, if we are to keep our freedoms, as individuals, and pay our debts.

This company must continue to search out, win and hold markets for nickel in all parts of the world. No difficulty, no hindrance, can relieve us from seeing to it that our products and services give to our customers the fullest value received.

B. I have been intending to ask you about some things concerning your career at the Nickel Company. You

were not long out of the School of Mines at Columbia University, and you knew no one at the company, but you got a job; in time, you rose to be president and, later, chairman. How did it all happen?

T. Well, there was an opening for someone to head up a newly created research department. I got the job. That is one way to get started in a company. Happen to be on hand when something new opens up. From then on I think the controlling factor is interest in your immediate job and, on the heels of this interest, is the need to recognize that your immediate job is only part of a much larger picture.

B. What moves a person into this larger picture?

T. Having started a new department, the time will come when you need help. Since you were first in the job, you will hire an assistant, or assistants. With a vital interest in the success of the immediate job, you will try to find men who are more competent than you are. Sooner or later, having such men, you will not be needed in that department. The men you hired will push you out — into a larger, and better, job.

B. Are you saying that two elements controlling promotion in a company are (1) the ability to recognize competence, and (2) the willingness to employ it, even at the risk of your own job?

T. Yes, but more fundamental than anything else is interest in what you are doing at the time — plus an interest in all the affairs of the company, whether you have any direct responsibility for them or not. The modern industrial company is a very complicated organization, hence there is no limit as to where this interest may profitably extend, provided it is centered about the company and the work it performs.

Another factor is an ability to fit the functions of a new department into the over-all operations of the company. It is this ability that moves a person into the larger picture, and this provides the opportunity to get a wide, and still wider picture of the whole industry. To me, it is quite natural if you do enough different things in a company you will get this wider interest. Or, perhaps, it is the interest itself that sends a person looking for other things to do. I have never been quite sure which way it works.

B. But you are quite sure, whichever way it works, that no one will progress toward the top in a large organization unless he is interested in all the things that affect the company?

T. Certainly, and there is another requirement. The individual has to take on his own responsibilities and, as he goes along, the responsibilities of other people.

B. Meaning what?

T. Didn't I ever tell you the story of my first boss, R. R. Maffett?

B. No.

T. That's funny. I thought I had told you. One day a man in New York telephoned me, saying something like this: "I was in Monell's office yesterday when there was a terrible row about you. Monell got a letter from one of our customers. In the letter, the customer raised the devil over something you had done, or not done.

"Monell sent for Maffett, and started laying in to you. Maffett said, 'Now wait a minute, Mr. Monell. Thompson works for me, and I take full responsibility for anything he does, and in this case he was working

under my direct instructions. So, we're not talking about Thompson. We're talking about me.' "

The next day Maffett stuck his head into my office, and said, "There was a hell of a row up in New York yesterday. I never found out what it was all about, although Monell said somebody was making a kick about you. You better go up to New York, and get the matter straightened out." He "never found out what it was all about," but since I was working for him he unhesitatingly took full responsibility.

B. Have you ever been in the same fix with people who worked for you?

T. Yes.

B. What did you do?

T. The only thing I could do. What Maffett did. It's a nice lesson to learn when you are in your twenties, and just starting out.

B. Are there any other controlling elements that enter into getting ahead in a large company?

T. There must be, although I don't think of any at the moment.

B. All right. Let's put them together. Most important, if he expects to get ahead in a large company, a young man's primary interest must be in all branches of the company's affairs; afterwards, he must be able to recognize unusual competence; he must be willing to hire it; he must be able to fit a new department into an over-all picture; and he must be loyal to his own people, with full acceptance of responsibility not only for his own actions but for the acts of the people working for him.

Altogether, that makes five requirements. Having established possession of the necessary qualities to meet these requirements, what becomes of the young man?

T. In the course of time he will be somewhere around the top of the organization. Getting there, his conscience will be clear because as he went along each department was better without him than it was with him. The management was perfectly satisfied and, since the individual was being pushed upstairs all the time, his personal selfishness also was satisfied.

That's one way to get ahead in a big company. Let the boys push you out of one job into another. You will wind up all right. So will the company. So will all the people who helped.

B. You make it sound pretty simple.

T. It is simple. Very simple. But, and this you must understand: What I have said is only a personal solution. Other men have other ambitions, and lead happy lives satisfying them. They may well disagree with me, and I can understand why they would. By giving their lives to fundamental and vital activities in a company, they are the star players.

B. Just the same, and whether you realize it or not, what you have been saying is that you have been a sort of "jack-of-all-trades" — a man who was never the best but who, apparently, willingly settled for being the "second-best."

T. What's wrong with being the "second-best man"?

B. It's quite a comedown from being a president, or a chairman.

T. No comedown at all. Just the reverse. To be the second-best man in each activity in the Nickel Company would be my ideal. Unattainable, but my ideal.

To be as good as the best man in every department would be impossible — but to know enough about each department, and to know enough about its work to understand and listen with sympathy; to have enough knowledge to have critical judgment as to the soundness of ideas and the way they were being executed; and, added to those advantages, to have a broader and more informed judgment on the various problems that come along than anyone could have who devoted himself to being the very top man in his particular field, would be wonderful.

I don't diminish the value, nor the importance, nor the worth of the great contributions made by men in charge of the departments of a business. All I am saying is that I can think of no better ideal for myself than the one that is unattainable — being "the second-best man in each activity in the Nickel Company."

B. You have been with one company for more than fifty years. I have heard you say they have been pleasant years because it has been a pleasant place to work. But something more than just being a pleasant place to work has to be involved. What is it? Or, are there a number of things?

T. I do not think it is possible for anyone to answer that question. That is, to pick out one purpose and say, with any confidence at all, "Here is the real thing — the real reason." I'd rather look at it this way: "What does one work for?" The answer is, I believe, to get some sort of satisfaction.

In the first place, everyone must justify his existence to himself. For myself, I am in the metal business.

Other people till the soil, and raise food. Others go to sea, and bring back fish. Others cut down trees, and make houses out of them, or paper, or furniture. Other people dig metals out of the ground and make them useful. To me, we are the people who carry the rest of the world on our backs. It may be childish, or childlike, for me to say that but I do have the feeling that I am connected with a fundamental occupation, something that always has been here. That I am one of a procession of people, going back and back and back.

It is a long procession which will continue well beyond myself — people who will spend all their abilities and all their strength to try to make these metals useful to the world. For some of us, that is our motivation.

B. Which is one way of saying that a man who believes in what he is doing invests himself in what he believes — and if he doesn't believe, he doesn't invest himself.

T. I would think so. I don't suppose there is a dividing line between the basic philosophy of an individual and the manner in which he operates a business. I don't see how there can be a dividing line.

There are certain fundamental convictions that govern the conduct of an individual just as there are certain fundamental convictions that govern the operation of a business.

A business has a character of its own, a distinct character. How we got our character is easily explained. The people who started this business hired the kind of people they liked. These kept right on hiring the same kind of people, so as the years

accumulated, the company took on a recognizable character. Being made up of people who work together, an atmosphere was built up because people of different character just sort of drifted out, and moved away. When you try to put into words what this atmosphere is, it is hard to do; and yet, it is easy to illustrate.

I have illustrated it dozens of times at company meetings by pointing out, "If Monell were here today, you people would like him and he would like you. If Stanley were here today, he would like the crowd, and the crowd would like him."

It runs through to Professor Henry M. Howe and to Professor Edward Peters. I knew both of them. If they could be here for meetings in the Research Department, I am sure everybody would like them, and they would fit in perfectly with today's people.

B. Following the Korean War when stockpiling and big defense consumption meant that nickel was temporarily in short supply for civilian uses a good deal of nickel sold at one dollar, two dollars, and even three dollars per pound, but Inco's prices to the trade remained firm throughout this period at sixty-four and a half cents per pound. Why didn't the company push up its price?

T. For many years the company had been trying to stimulate new and growing uses by selling its nickel at stable and reasonable prices. This made it easier for customers to size up the prospects of commercial success in promoting products using Inco nickel instead of something else. This was important. In many cases it meant changes in manufacturing processes, changes in the design of products, readjustments in sales and advertising, as well as convincing their distributors so that all were committed to the position that nickel, or some nickel alloy, was the preferred material for a particular purpose.

To have taken advantage of an artificial shortage to crowd up the price of nickel would have gone at cross purposes with Inco's traditional objective of building greater and more diversified markets for nickel. Inco felt sure that its attempts to sell at moderate, stable prices and to keep away from frequent price fluctuations were in the best long-term interests of Inco as well as those of its customers and the communities in which it and they operate.

B. These are times when a great deal is said about primary education, technical education and graduate study but no one seems to be saying much about the craftsman. Or, have we reached the stage, educationally, where men and their hands — in other words, craftsmen — are becoming obsolete?

T. Certainly not. There has been no change excepting, perhaps, in emphasis. In 1906, when I came with the company, the college graduate was looked down on in the plant.

Quite early I figured that if I was going to get on a proper footing with the plant people and get ahead in the nickel business as well, I had to learn how to do a lot of things that I had never learned about in school. These were things metal people had learned, and passed along from generation to generation.

It was fantastic how they could look in a furnace, judge the temperature, and tell when the metal was ready to pour. One week I ran a succession of tests with an old refiner. We tested each day when he said the charge was ready. He was as good as the pyrometers we had then.

B. How could he tell when the metal was ready to pour?

T. By looking at it when the slag had been pushed back — looking at a "clean face" as it was called, he got to know, or he never learned — and if he never learned he never became a refiner. In my lifetime I have worked with a great number of highly skilled, rule-of-thumb metallurgists. Some of them could hardly read, or write, but the knowledge they had represented a great mass of experience that was not available in any book. One example was the manufacture of malleable nickel. To make malleable nickel it had to have the right carbon content and be poured at the right temperature. Then as a final step they added one and a half ounces of metallic magnesium to one hundred pounds of molten refined nickel. This last depended on a discovery of Fleitmann in Germany.

In 1878, Dr. Fleitmann discovered that if a few ounces of magnesium were added to one hundred pounds of molten nickel the product was malleable, both hot and cold, whereas, without the addition of magnesium it was brittle at any temperature. Of course, as I said, the nickel had to have the right carbon content, and had to be poured at the right temperature.

The old refiners depended for their carbon analysis on taking a small ladle, about the size of an American fifty-cent piece, taking a sample of the molten metal, plunging it into water and observing the frozen surface in the same manner that copper refiners had judged copper from time immemorial.

To judge the proper temperature, they knocked back the slag on top of the molten metal in the furnace with an iron rabble, and observed the surface condition of the freshly exposed metallic surface. Both of these tests, the judging of the carbon content and the judging of the proper temperature, were done without chemical laboratory or pyrometric equipment. Both depended solely on observed phenomena. In learning to perform these two operations, the beginner took one great step in learning metallurgy as an art, or craft, and not as a science. Based on these methods alone, men produced malleable nickel for nearly half a century. Their explanations as to the reasons for the change that turned brittle nickel into malleable nickel were various and weird. Some of the reasons even reached the technical literature.

After working for several years at the refinery, I knew only two things. One was that the facts were right because day after day the procedure worked successfully; the second thing I knew was that all the explanations were untrue. It was not until he was working at the United States Bureau of Standards in the second decade of the present century that Paul D. Merica discovered the real reason.

For many centuries men refined metals by similar empiric methods and depended upon their powers of observation and memory, first to observe and then to pass on the secrets to chosen disciples. How it all began no one knows. Probably some prehistoric man accidentally built a fire on some readily smeltable ore.

Observing that from the results of the heat a strange and useful substance had melted and run out, he took the enormous technical step of searching for the same earthy material and deliberately building a fire on it so as to obtain the resulting metal.

Over the centuries was built up the art of metallurgy before there was a science. Through these years men observed and passed on by word of mouth a great store of knowledge which permitted them to convert metals in the earth to the uses of man. Approached in the proper spirit, these craftsmen will teach you things not in any textbook, and can bring to the technically trained mind essential points which are learned only by doing, or by observation, while they are occurring. The professionally trained metallurgist who masters a sufficient number of those things which go to make up the art of metallurgy has not only enormously enriched his understanding of his chosen field, he has enriched his whole life.

Thompson again:

As with all incorporated companies, this company has a board of directors. In some companies with very restricted ownership, the directors are, at the same time, the owners and the managers. In a large company with many shareholders, the functions of the directors are quite different.

In the first company, each director represents some section of the shareholders and, to that extent, represents a selfish interest. In the large public corporation the directors should not represent any special interest; each director should represent the interests of all the shareholders. The International Nickel Company of Canada, Limited, is such a company.

We operate in three countries, and in general, our shareholders are concentrated in the same three countries, although ownership of the company is scattered all over the globe. This requires directors of different nationalities and, so far as possible, of widely varied experiences.

We need men from each country who are experienced in financial affairs. We need men who know the laws. We need men who have contact with public life and, since we are a mining company as well as a company whose products are widely distributed to industry, we should have a man, or men, from a large mining company; also, we should have directors from the consuming industries such as the chemical industry, the oil industry, food, steel, railroads, etc., although not necessarily connected with companies which are large consumers of nickel.

The function of the directors in a large company is to advise and control — and, having selected the management to give to it the best of their experience and advice, to agree or to disagree, and to determine among themselves and with the management the fundamental policies which control all the company's actions. Also, to bring to the affairs of the company an independent, uncontrolled judgment of what is being done, and to give expression to that judgment; to watch the progress of the company and the results achieved by the management; to see that continuity of management is maintained and, as representatives of the shareholders, to change the management if, and when, the occasion requires.

As I think has been said elsewhere in this book, the function of a mining management is to be both visionary and realistic — at the same time. The directors must

have this same combination of qualities. They must be visionaries who are ready to risk large sums of money on exploration, the building of new plants, and the investment in new processes.

They must be realists in insisting that these expenditures be profitable. And, beyond all else, they must be men of outstanding and recognized integrity, so the shareholder is satisfied that the decisions of the Board are reached not through selfishness, and not through personal influence, but because, as directors, they believe that what is being done is for the best interest of all the shareholders.

It is my confident belief that the real protection for a country is not found in its laws, but in the integrity of its people; likewise, it is my confident belief that the real protection for a company's shareholders is not found in the size of the company's bank accounts but in the integrity and ability of its directors. In fact, that is the shareholders' greatest protection.

The Nickel Company has always been fortunate in its directors. With their other qualities, they have always been men with commercial courage. For illustration:

In 1922, we in management told the directors we had developed our Monel alloy to a point where we could go no farther without a mill to produce it. We told them we had no market developed which would justify a mill, but we assured them that with a mill we could build a market which would earn the preferred dividend.

With this promise — and in a time when there was practically no market for nickel — the directors invested three-quarters of all the liquid resources of the company in a mill in Huntington, West Virginia, to supply a market which management had said did not exist but that, with a mill, could be made to exist.

The result justified the decision.

Within quite recent years, the directors continued to authorize the spending of money for more and more exploration in search of nickel deposits. For ten years the directors continued to put up this money in the belief that they were morally obligated to the shareholders to protect the ore reserves the company already had, and to provide other reserves for the future.

When the ore was found, the directors agreed to go ahead, and appropriated over a hundred million dollars to build a plant in Manitoba. Even when the nickel market was declining in 1958, the Board was fully united on the idea that the company must continue to push the operations in Manitoba to completion if it were to fulfill its function as the world's largest supplier of nickel.

There never was any question of retrenchment, or of slowing down in the plans for Manitoba. We went right ahead to build as if we were building in a time of shortage. This means that the directors loaded the responsibility for the new production on the management; where it belongs. It is the responsibility of management to see that this tool works efficiently, economically and profitably.

In starting any new operation there are countless difficulties. It is a tremendous job to start a big operation and get it running successfully. Likewise, it is a time when management must have confidence in its own ability to solve continually arising difficulties; for its part, the Board must have confidence that management will not fail.

We have always had such boards — visionary as to what the future might bring, realistic as to what it should ask in the way of results but always courageous, always filled

with the belief that the company can, and will, lick the constantly recurring problems.

B. In 1926, when you and Lawson, who at the time was your European Sales Manager, went to Europe with Stanley and worked out the plan for the Bureaus of Information, the general idea was to do something that would increase the nickel consumption abroad. That's right?

T. Yes.

B. The idea has worked out well, hasn't it?

T. Oh, yes. Within a very short time, less than a year after we opened the first one — in Paris, it was — it had proved its usefulness. The same thing is true of our distributors which also are located in different parts of the world. The task of developing new markets, like the task of increasing the supply of nickel, is not one that can be done overnight. It is a job that requires continuing activity over a period of years.

It is becoming increasingly recognized by our customers that when we supply nickel we also supply, as part of our service to the trade, commercial and technical information which makes the path of the consumer easier and more profitable. Knowing that no metal is commercially valuable unless it can be bought at some readily accessible point of distribution in the forms in which it is to be used, we have given a lot of thought, and time, to the building of our network of distribution and information centers.

And, as with everything we do, it all goes back to the character and ability of the men who are doing it.

It is thought and time that have been so well invested that when I get to my feet in England, or elsewhere in the world, and make a speech I am able to tell my listeners that if the countries of the world could get along together the way the people in the Nickel Company get along together we would not have any of the troubles that always seem to be bothering us as nations. I am sure it is because in the Nickel Company people work together, and live together, in an atmosphere of mutual aid and mutual confidence.

These two things, along with the integrity of the individuals involved, are the major elements in the success of the centers.

B. To go to Emerson again, you agree with his dictum that "character is higher than intellect"?

T. I do. There are other factors that also help. When people are building something together the fact that they have the same goal tends to wipe out the small misunderstandings that always arise in human affairs.

From its beginnings Inco has been run like a small company, and the closer we come to keeping it that way, the better. As soon as you begin to put things down on charts, people tend to get behind fences. Or so it seems to me. It also seems to me that by holding to the small company approach, we anchor ourselves more firmly into what should be the real rule of conduct for any company — mutual aid and mutual confidence.

People have trusted me all my life, and I have trusted them. I could not sit at home at night if I worried about the folks who run the London office, run The Mond Nickel Company, and the folks who run Copper Cliff, the Manitoba operations, the Toronto or New York offices, or any other part of the company.

I was assistant to Stanley for years. He was the man who saved the Nickel Company in 1922. He was the one in whom everyone had confidence. People had confidence in him, and trusted him.

I worked for him for forty years on that kind of basis. Sometimes things went wrong but there never was any idea that they went wrong through any ill intention on his part, or mine. If you wanted to evolve a philosophy, or whatever you want to call it, of a company, I don't believe you could think in any better terms than in the terms of mutual aid and mutual confidence.

Thinking in such terms you will be surprised at the things that will be done for you. Something you neglected to do, somebody will do for you. It will not be his job at all, but he happens to be around and sees you have missed doing what you should have done. He either does it for you, or tells you about it. That is the spirit we have encouraged throughout the company.

This goes for Germany; it goes for France; it goes for England; in fact, it seems to go for people who have no official connection with the company excepting for the fact that they have been associated with it as advertising people, or lawyers, or consultants. They always speak of the Nickel Family. It isn't only I, there are a lot of people who speak of it that way. These people can go to France and feel at home, or they can go to Japan, to Australia, to South America. They will feel at home.

Appendix

Streets Come to Sudbury

THE offer the Canadian Pacific Railway made to the young doctor and his wife was irresistible.

They were newly married; the small town of Delhi, not far from Lake Erie in western Ontario, where they lived, already had three doctors so there was little demand for youth and new ways, with age and experience near at hand. Small wonder, then, that William H. Howey, recently a graduate of the medical school of McGill University in Montreal, and his wife, Florence, were looking around for a community in which there were fewer doctors and more sick people.

It was while they were looking that Howey saw an announcement in the Toronto *Mail* (now the Toronto *Globe and Mail*) that the Canadian Pacific Railway was looking for doctors. He wrote a letter of inquiry, and received a prompt reply.

The company offered a salary of $75 a month; quarters would be provided; there would be no rent to pay, no coal to buy, no taxes to meet; drugs, medicines and instruments would be supplied. With an average national wage of one dollar a day, the offer sounded like sleigh bells at Christmas. The year was 1882.

Late in December the young doctor received a summons: "Report for duty at once." Two days before Christmas he left Delhi, and in March 1883, he wrote his wife "to come, but do not bring any furniture." After nearly three days of travel, she joined her husband at Sturgeon Falls.

Fifty years afterwards, in writing about those days,* Florence Howey recalled the open water, and

> the long "red pointers" rowed by the French Canadian boatmen. It was lovely toward evening when the sun was shining through the tall tree trunks which bordered the river to hear them coming, singing their native boat songs.
>
> One bright morning in May, I was alone, and awakened early. Soon I became aware of a peculiar sound, a sort of musical murmur. I could not decide what it was, so finally my curiosity got the better of my laziness, and I got up to find out. As I opened the door the warm spring air, laden with the perfume of pines, met me, the dew sparkled on the fresh young foliage, green things were springing up in the forest, and the birds were simply mad with song.
>
> As I walked down the path toward the river, whence the sound seemed to come, I felt like singing myself, and was more lighthearted than I had been

*Published in 1933, and republished in the Sudbury *Daily Star* on August 4, 1953. Copyright, 1953, Sudbury *Daily Star*.

> since leaving my old home. As I turned a bend in the path a beautiful sight met my eyes. An altar had been set up beneath the tall pines near the river, the trunks, the pillars and the leafy tops, the vaulted roof of this nature's cathedral; and around a white-robed priest, hundreds of rough navvies devoutly knelt to receive his blessing.
>
> He had arrived to celebrate the Easter Mass, and these men had come for miles, from both east and west, to perform their Easter devotions, and it was the solemn murmur of their united voices which I heard. . . .*
>
> The month wore on, and one day there seemed to be a flutter of excitement among the population. I was curious and went out to see what caused it. I met a little boy and asked him what was going on; he said, "The railroad is coming." A cluster of people were standing by the unfinished track and, sure enough, away down the road I could see a puff of smoke. It was catching up with we forerunners, and in a couple of days the ties were laid and the rails placed, and the engine steamed proudly past us, tooting a salute while we cheered and waved hats, handkerchiefs, aprons or whatever was available.
>
> The iron had overtaken and passed us; that meant that we too would soon move on. We must keep ahead of the "iron" . . .

Finally, the order came for the doctor and his wife to move on, this time to Sudbury. They packed their trunks,

*In 1883, Easter came on March 21, but the territory was so large, and travel was so difficult, that the priest was long delayed in reaching the distant mission.

loading them along with boxes, a bedstead, six chairs, a washtub filled with dishes, and two stoves on a flatcar. Florence Howey climbed up and established herself "on a bale of hay, with two more bales standing up to complete quite a comfortable seat."

At sunset on July 1, 1883, she had her first sight of Sudbury. The community was three months old. Between the stumps of trees were a Hudson's Bay store, the beginnings of four or five houses, and a hospital. The hospital was a one-story structure made of rough logs. Dimensions were about thirty by forty feet, and completion was delayed awaiting doors and windows. There was one room, with bunks on three sides. Each bunk was fitted with a mattress, a pillow and gray blankets.

The Balmoral Hotel, a wooden building, was in operation; there were stables for horses, and a camp for construction workers; there were two boardinghouses, one owned by Dan Dunn, the other by Henry Smith. "We had supper [at Smith's] and I remember it well," she wrote. "Fried salt pork, potatoes, bread, strong butter and evaporated applesauce."

Water came from "a good, clear, cold spring which bubbled out of the sand where the Athletic Park now is. It supplied the whole town with water for many years. A man by the name of Perras was the waterman. He brought it around in barrels, and filled the family water barrels, carrying it in pails and splashing the floors a good deal in the operation. It was the only water we had to use for all purposes. It cost twenty-five cents a barrel. . . ."

There were no cows and no chickens in the immediate countryside. As a result, milk and eggs were seldom seen; butter was scarce, and often rancid. Canned fruit and

vegetables were almost unknown. The Hudson's Bay store carried potatoes and dried apples, flour, baking powder, sugar, salt, and salt meats. In season, wild raspberries, strawberries, grapes, and other fruits were plentiful; behind the hills there were lakes well populated by whitefish and bass and pike and, on the edge of one of the lakes — Whitefish — was an Indian village, so storybook that the doctor and his wife visited it at the first opportunity; and came away remembering most:

> The burying ground was on a high hill overlooking the village. There were quite a lot of graves, and it was pathetic to see so many new-made graves of little children. It did not speak well for the continuance of the tribe.
>
> Tiny graves were adorned with bright-coloured pebbles and bits of broken china, and festooned from the two pieces of board, which marked the grave, were little pieces of strips of pretty coloured cloth, knotted into lengths of twine, anything which the wee one may have treasured. The graves of some of the more important braves had small log structures over them.

Before another year was over, the railroad tracks were well to the west, and churches were coming to Sudbury. A two-story structure, built of logs shipped from Montreal, was used as a church and as a school.* The second floor was a Catholic chapel, the pastor being Father Jean Baptiste Nolin; the first floor was a public school. Margaret Smith was the teacher. Her salary was met by all denominations.

*The present site of St. Anne's rectory.

The first Anglican clergyman was Rev. Gowan Gilmour, who came on snowshoes from Algoma, nearly one hundred miles away; ministers of other denominations came from North Bay and held services wherever they could, usually in private homes until their small meeting places were ready.

Left behind, after the tracks went through Sudbury, was a large amount of work. Wooden culverts and bridges had to be replaced in steel and stone and cement; trestles had to be braced, a railroad yard provided, a station built — all sorts of undone things had to be done. With the arrival of spring in 1884, J. L. Morris, provincial land surveyor, was laying out the town. He had staked out, but had not named, two streets, Elm and Durham; and, as Mrs. Howey wrote:

> Elm Street became the business center.
>
> John Frawley started out with a $500.00 stock of gents' furnishings in a tent twelve by eighteen and he made so much money that he excited the envy of a young man by the name of "Bob" Tough, who wanted to go in with him on a fifty-fifty basis, but he could only raise $488.00. However, he had a good tent eighteen by twenty-seven which made a grand addition to the premises. So it became Frawley & Tough.
>
> Then Bob's brother set up a pool table in a tent next to them, which was a good idea as it drew customers to both places. The next business venture was a barber shop which George Tuddenham started in a grand rough board shanty. Of course, that flourished with so many men wanting hair cuts, and their whiskers (which all wore then) trimmed, so the

> boom started. Zotique Mageau pitched a tent and went into the boot and shoe business.
>
> Frawley & Tough did not have the monopoly on the gents' furnishings very long as Pat Manion went them one better, for he started in the same business but in a board shack with a lean-to room. There were others but those are the only ones I remember distinctly. Looking down Elm Street from our door, there was nothing but bush to the Balmoral and from there on the street was lined on either side with board shacks and tents, the road ankle deep with mud every time it rained, and not a board to step on, though here and there a root, or a stone.

But Sudbury grew up fast. Another boarding house was built on the corner about where the Mackey Block now is. Dan Dunn ran that, a notable character, famous for his kind heart, charitable nature, and ready command of an extensive vocabulary of choice oaths, which he made use of when he considered them useful.

After Robert Burns left the C. P. R. store, Mr. Stephen Fournier took over the management of it, and the post-office. However, he (Fournier) was not long in Sudbury before he was tempted by the success of the newcomers in the mercantile business to set up in business for himself. Mr. Fournier bought some land across the creek from the Catholic Church and built a store and dwelling combined.

He took the post-office with him, which move did not suit at all. It was a muddy walk to the creek, which was spanned by a bridge of loose planks laid on logs, with other logs on top of them to hold them in place. When the creek flooded, the bridge was under water with only the tops of the logs showing over which we had to walk to get our mail.

Fortunately, there were no old people, and I don't believe there were any infirm people here, and most of us were pretty good at walking logs, and I did not hear of anyone getting a ducking in Nolin Creek. Mr. Fournier remained there until 1886 when he built a store at the corner of Elm and Elgin Streets, known as the "Golden Ball," because of the immense golden ball perched on the gable. . . .

As we are going to have a real passenger train sometime, and people will want tickets and waiting room, and baggage checked, a real station was built. C. J. Rea was the first agent and C. W. Waggner, telegraph operator. Wood-burning engines were in use and as the tenders would not carry sufficient fuel for long distance stops, wood was cut and piled at intervals along the track, so when fuel was getting low the train stopped and all hands helped "wood up."

After this, more and more people began to arrive, and, of course, the more people the more need for the necessities of life, and the more business, and the more work for those who came. Store buildings took the place of tents, and tar-papered wooden shacks, and more dwelling houses of a better class were built, and streets were laid out.

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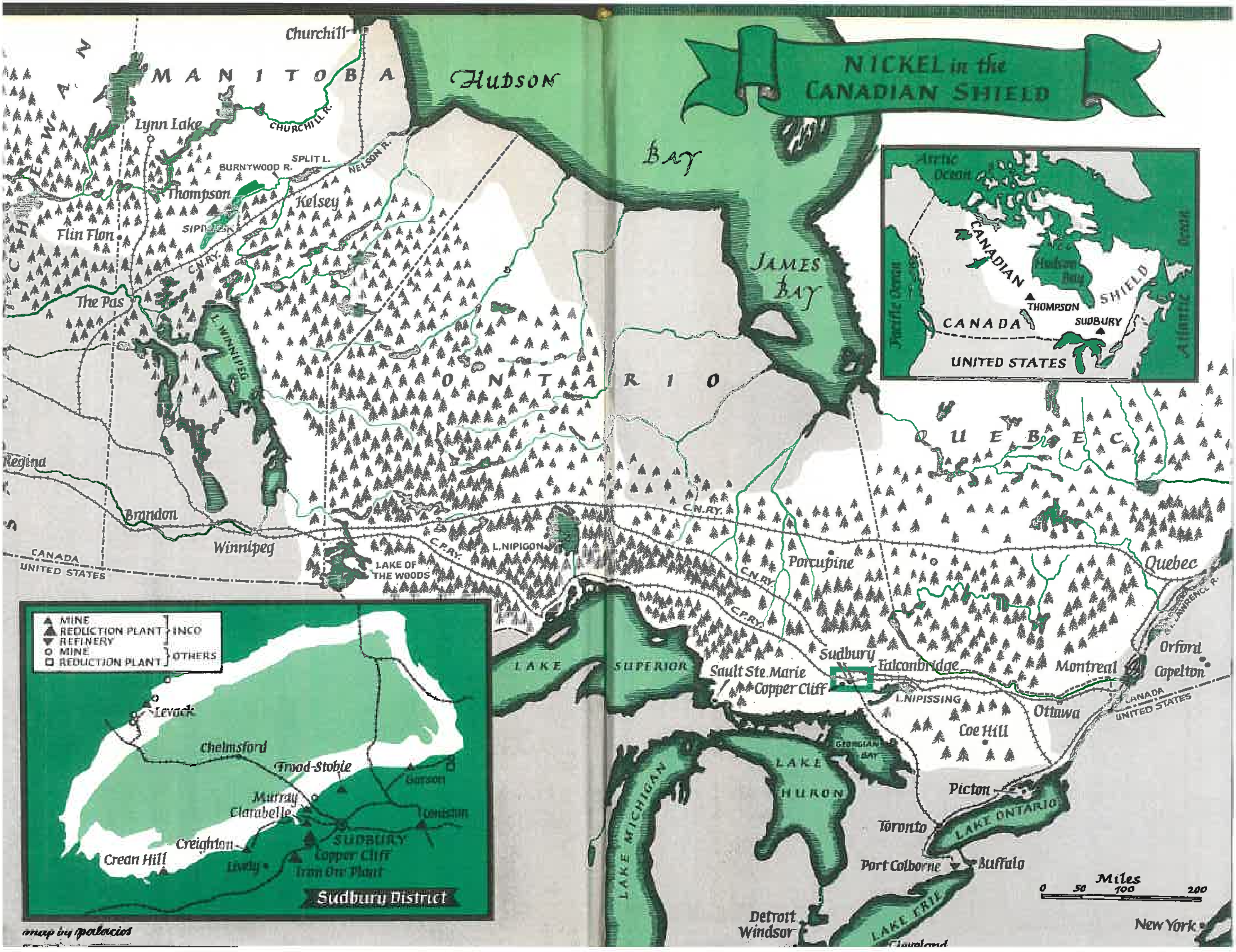
NICKEL in the CANADIAN SHIELD
Churchill
MANITOBA
HUDSON BAY
Lynn Lake
CHURCHILL R.
SPLIT L.
BURNTWOOD R.
NELSON R.
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Kelsey
Flin Flon
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The Pas
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L.NIPISSING
Montreal
Orford
Capelton
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Coe Hill
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LAKE ONTARIO
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Coniston
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