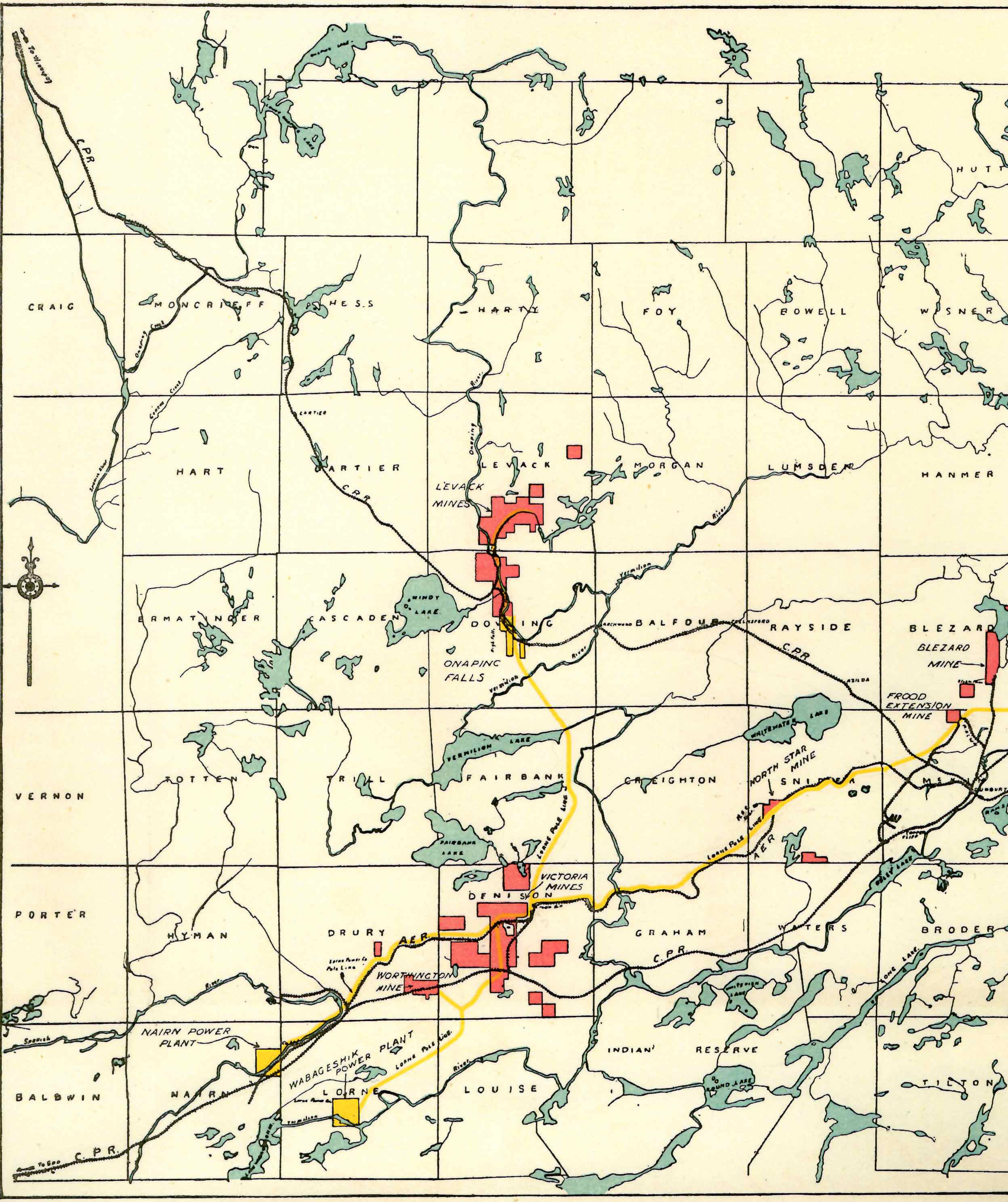
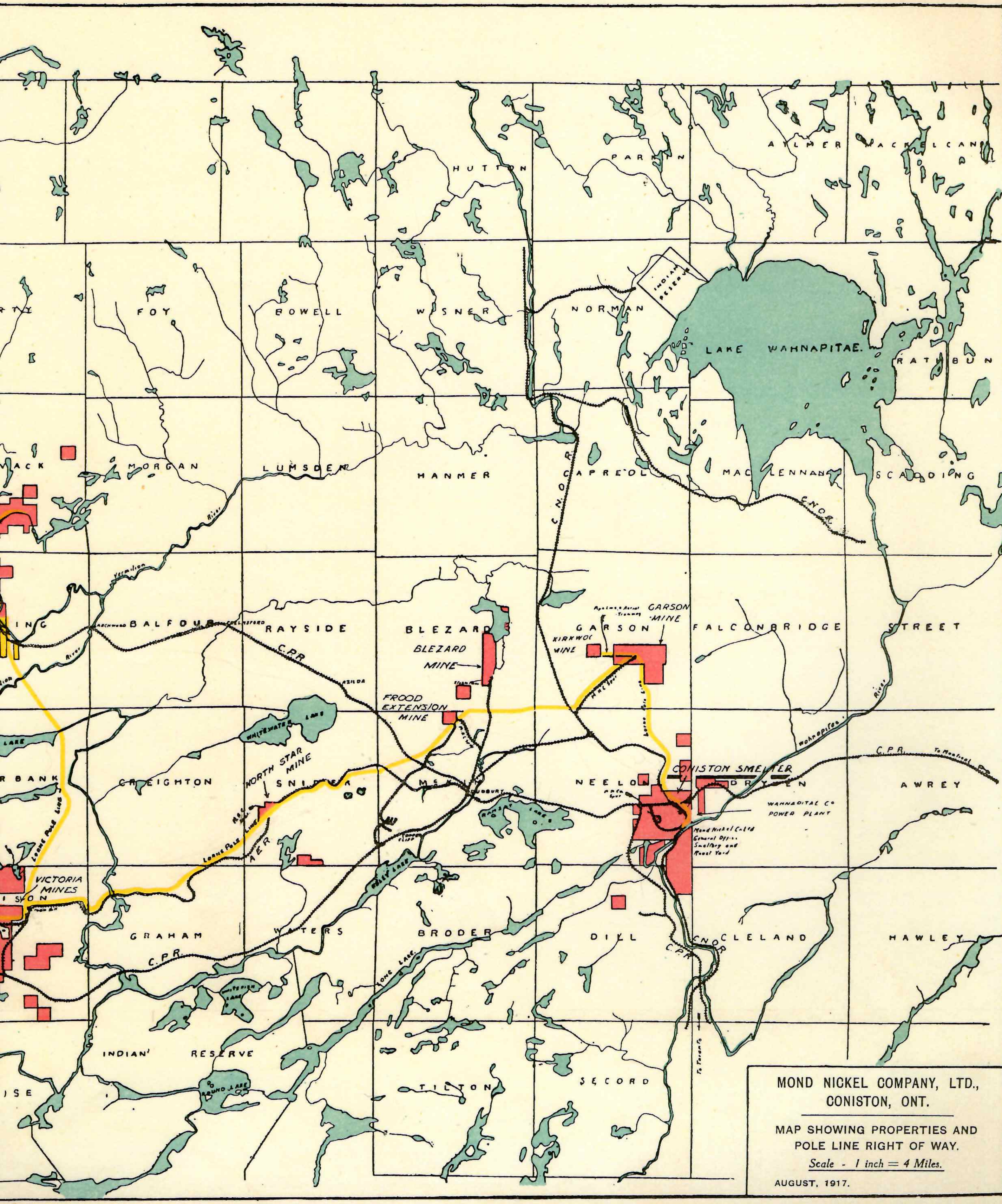
THE MOND NICKEL COMPANY, LIMITED.

1918.

MAP OF THE MOND NICKEL COMPANY'S PROPERTIES IN THE SUDBURY DIS



KEL COMPANY'S PROPERTIES IN THE SUDBURY DISTRICT, ONTARIO, CANADA.



Mond Nickel Company's Power Plants and Transmission Lines = Yellow.
Do. Other Properties = Red.

The Mond Nickel Company, Limited

Authorised Capital	£2,400,000
Issued Capital	£1,880,000
Debenture Stock	£875,000

Directors

ROBERT L. MOND, J.P., F.R.S.E. (*Chairman*).

Rt. Hon. Sir ELLIS J. GRIFFITH, Bart., K.C., M.P.

Sir ROBERT A. HADFIELD, Bart., J.P., F.R.S.

Sir EDMUND WALKER, C.V.O., L.L.D.

C. V. CORLESS.

C. LANGER.

ROBERT MATHIAS.

BERNARD MOHR.

EMILE S. MOND.

SAXTON W. A. NOBLE.

Secretary

D. OWEN EVANS.

Registered Offices

39, VICTORIA STREET, LONDON, S.W.

February, 1918.

Mines and Smelting Works in Sudbury District of Ontario, Canada

Canadian Office and Smelters - Coniston, Ontario

Manager	C. V. Corless.
Chief Mining Superintendent	Oliver Hall.
Smelting Works Superintendent ..	J. F. Robertson.

Refining Works, Clydach, South Wales

Managing Director	C. Langer.
Works Manager	F. J. Bloomer.

CONTENTS

THE MOND NICKEL COMPANY LIMITED

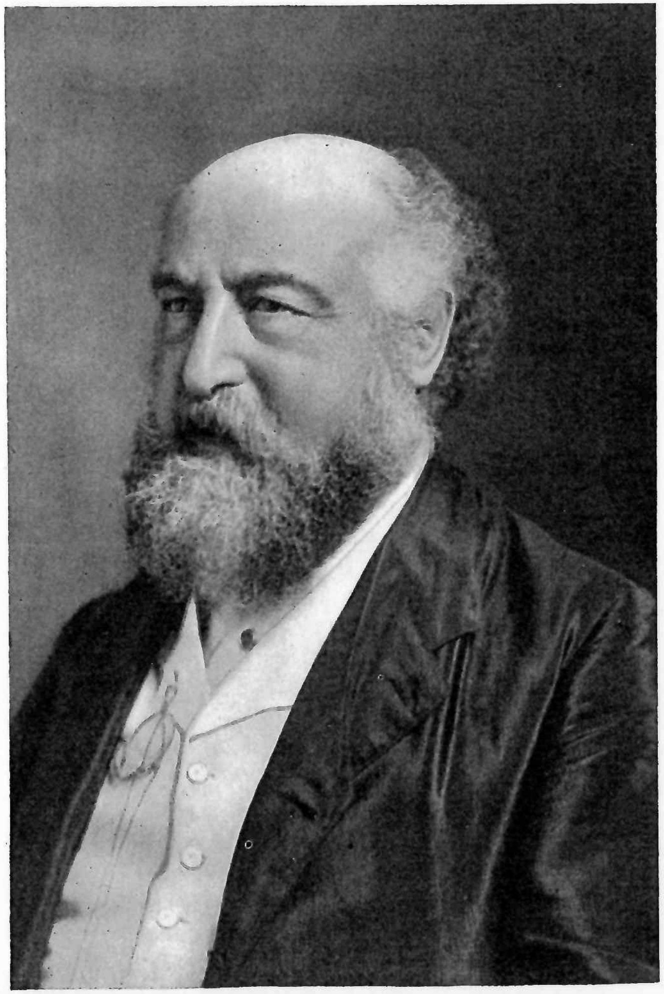
NICKEL may certainly be classed amongst the more modern metals, although alloys containing Copper, Nickel and Zinc are said to have been used by the Chinese from time immemorial. The discovery of Nickel in modern times, however, has been attributed to Cronstedt, a Swedish chemist, who worked in and about the year 1751, but it was not until the year 1775 that the metal was obtained in its pure form.

The Nickel mines of Scandinavia were probably the first to be worked on a commercial scale until the discovery of very large deposits in New Caledonia, and later in Canada, led to rapid progress in the development of the Nickel industry.

With the ever-increasing demand for faster ships, boilers to work at higher pressure, greater strength with lighter girders, heavier guns and more irresistible projectiles and—as a natural corollary, armour plate capable of offering increased resistance thereto—to say nothing of the numberless other applications of Steel to the service of man, it is obvious that in order to keep even pace with the march of the times, recourse must be had to a material of higher tensile strength, and one possessed of greater toughness and increased ductility than anything that ordinary Carbon Steel can offer. Indeed, it is literally true that the Alloy Steels in use at the present time are bringing about nothing less than a series of revolutions in the various industrial fields in which Steel is largely employed; and as Nickel plays a leading part in modern Steel practice, the importance of the metal is so obvious as to require no emphasis.

FOUNDING AN IMPERIAL INDUSTRY

One of the most interesting events in the history of Nickel was the discovery in 1889, by the late Dr. Ludwig Mond, F.R.S., of a volatile compound consisting of Nickel and Carbon-monoxide.



THE LATE DR. LUDWIG MOND, F.R.S.,
FOUNDER OF THE MOND NICKEL COMPANY.

While he and Dr. Carl Langer were experimenting in working out a method for the elimination of Carbon-monoxide from gases containing Hydrogen, they discovered that Nickel possessed the remarkable property of forming a volatile compound with Carbon-monoxide, which compound, when heated to 150°/180° C., is split up into metallic Nickel and Carbon-monoxide.

On this reaction was based an entirely novel process for the production of metallic Nickel of practical chemical purity.

This process has been fully described by the late Professor Sir William Roberts-Austen, in a paper read before the Institution of Civil Engineers in 1898. Moreover, as a brief account of it will be found in the section of this book in which the Mond Nickel Company's Refining Works are described, it is unnecessary to go into further details here.

Dr. Mond eventually decided to develop this nickel-refining process on an industrial scale. The question of securing a sufficient supply of nickel ores had next to be considered. Dr. Mond secured the services of the Mining and Metallurgical Engineer, Dr. Mohr, who, on his behalf, visited and reported upon most of the nickel ore occurrences in North America, Norway, and on the European Continent.

As a result of these investigations, Dr. Mond, on the advice of Dr. Mohr, took an option on the purchase of the most promising looking properties in the Sudbury district. These properties were then, under Dr. Mohr's superintendence, examined by diamond drilling, which eventually led to the acquisition of the Victoria and Garson Mines in 1899.

Taking advantage of the magnetic properties of the Sudbury Nickel ores, Dr. Mond was the first to apply the magnetic dip needle, which had been successfully used on Iron ore deposits in Sweden, to the Sudbury mining fields. He engaged two Swedish engineers experienced in this work, who, by making a careful survey of the ore fields and noting down the lines of equal attractions, succeeded in defining approximately the extension of the ore deposits. Following up the magnetic surveys by diamond drilling it was possible to estimate pretty accurately the quantity of ore to a certain depth. By these means we were able to locate and acquire for the Company in the course of years, a large number of other important mining properties in the district, and thus establish the large ore reserves which the Company possesses.

About the same time, Dr. Mond began the construction of the Refining Works in South Wales.

At the present time Dr. Mond's invention is being worked by the Mond Nickel Company, Ltd., who own various Mines and Smelting Works in Canada, as well as the Refining Works in Wales. The head-quarters of the Company are at 39, Victoria Street, London. The Company was formed in the year 1900 to take over the Nickel Patents, Refining Works, and Mines owned by Dr. Mond.

The Company thus owns its raw material, the ore being derived from its own Nickel-Copper Mines in Ontario. The ore is mined and roasted, then smelted and converted into Bessemer matte, at Coniston, near Sudbury, Ontario. This matte, which contains about 80% of Copper and Nickel combined, is shipped from Canada direct to Swansea, for treatment by the Mond process at the Company's Refineries at Clydach.

SUPREME IMPORTANCE OF ALL-BRITISH NICKEL

Extensive Nickel-Copper properties have been acquired from time to time by the Mond Nickel Company in the Sudbury district, so that at the present time the Company hold some 29,000 acres of mining land. The history of the successive acquirements of mining properties indicates, better than anything else could do, the rapid expansion of the Mond Nickel Company's business.

When the Company was formed in 1900 the mining properties consisted of the Victoria and Garson Mines. Extensive exploration work has since been undertaken by the Company, and has resulted in the acquisition of additional mining properties in the townships of McKim, Drury, Blezard, Garson, and Levack, all in the Sudbury district, Ontario, Canada. Mining operations have been extended as rapidly as success in exploration permitted, so that at the present time five mines in all—Victoria, Garson, Worthington, Levack, and Bruce mines are now being worked.

The number of men employed by the Company in Canada has been gradually increasing with the opening up of various mines and the general expansion of the Company's operations. During the earlier years they numbered only 100 to 150, but since 1908 each year has seen an annual increase, until to-day about 1,900 men are employed, and it is anticipated that the number will shortly be increased.

With reference to the production of Nickel in Canada, the following interesting statement is made in the Final Report of the Dominions Royal Commission (Cd. 8,462, p. 34, par. 173, Mch. 1917):—

"The production is growing very rapidly, and the importance of this great asset can hardly be exaggerated. It represents, in combination with the much smaller output of New Caledonia, a virtual monopoly of a metal which is becoming of ever-increasing importance in the national industries, and is an absolute necessity in the production of satisfactory war material.

'When we arrived in Canada,' the Commissioners continue, 'our information led us to the conclusion that the proved reserves of ore containing on an average $3\frac{1}{2}$ per cent. of Nickel and $1\frac{1}{2}$ to 2 per cent. of Copper were not less than 70,000,000 tons. But developments have been so rapid that before we left we had reason to think that the reserves may be found to be not much less than double this amount.'"

The Commissioners point out in their Fifth Interim Report (Cd. 8,457, p. 45, par. 156) that this 70,000,000 tons of ore represents about 2,500,000 tons of pure Nickel.

"The Nickel produced in Canada," states this latter Report (p. 45, par. 152), "is of exceptional interest, not only in respect of its magnitude in relation to other sources of supply, but because of the invaluable improvements which its use has effected in the preparation of war material. As is well known, it increases both the strength and ductility of the steel, and it has, consequently, been freely specified by the Naval and Military Authorities for use in warships, guns and other war material."

"*It is, therefore,*" *the Report continues,* "*a matter for sincere congratulation that* 80 *per cent. of the world's output should be found within the British Empire; practically the whole of this is in Canada, and in the Sudbury district of Ontario.*"

The superlative importance of the Base Metal Industry has been prominently brought before the world by the war. In this connection, the Mond Nickel Company's enterprise has proved of the utmost consequence to the British Empire, of which it is now one of the leading industrial undertakings.

The fact that the Company's Mines, Smelter and Refinery are all in British territory is of great moment, as the Mond Nickel Company is the only undertaking which places on the market Nickel that is from first to last an entirely British product.

THE NICKEL-COPPER MINING PROPERTIES

OF THE MOND NICKEL COMPANY, LIMITED

THE MINING properties of the Company cover approximately 29,000 acres in the Sudbury district of Ontario, Canada, the most important source of the world's Nickel supply.

At the present time the most important mines of the Company are :—

Levack	Garson	Worthington	Frood Extension
Victoria	North Star	Kirkwood	Blezard

Bruce Quartz Copper Mines

Owing to the large ore reserves developed on the Company's properties, only the following mines are being worked at present :—

Levack Garson Worthington Victoria Bruce Mines

VICTORIA MINE.
ROCK HOUSE AND MINING PLANT.

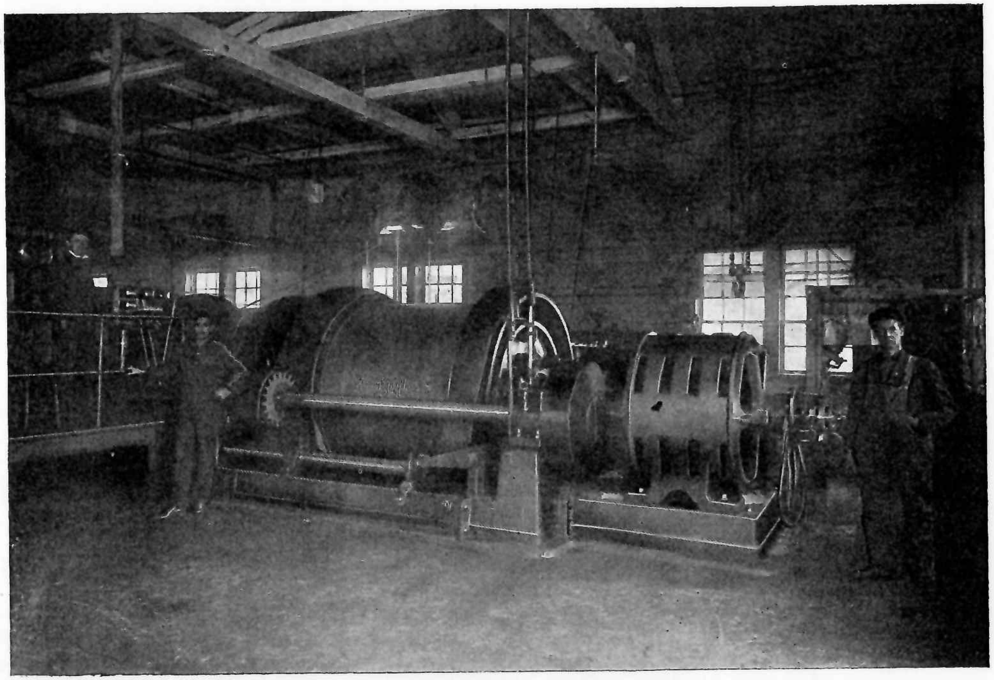
VICTORIA MINE

THE DEEPEST MINE IN CANADA

TO go for a moment into somewhat greater detail respecting the Mond Nickel Company's mine properties in Canada, we may refer, in the first instance, to Victoria Mine. This, the pioneer mine, was practically the Company's only source of ore during the first few years of its operations, and it still remains the most interesting of all its mining properties. Shipments were begun in 1901, and, with short interruptions, mining operations have continued steadily from that date.

The three-compartment vertical shaft of the mine is the deepest in Canada, it having been sunk to a depth of 2,600 ft., and is now being sunk to 3,000 ft. The west orebody is developed to the 2,600 ft. level. Up to the present time, the mine has produced over 600,000 tons of ore of high grade.

During the first eight years of work at Victoria Mine, steam power only was available, but in 1908, when the Company's electric power plant at Wabageshik on the Vermilion River was put into operation, the mine was equipped with electrical machinery, and since April, 1909, electrical power only has been used. To ship the ore to the Coniston Smelter, a new rockhouse was erected in 1913, from which the ore is shipped to Sudbury by the Algoma Eastern Railway and thence by the Canadian Northern Railway to the Company's Smelter at Coniston.



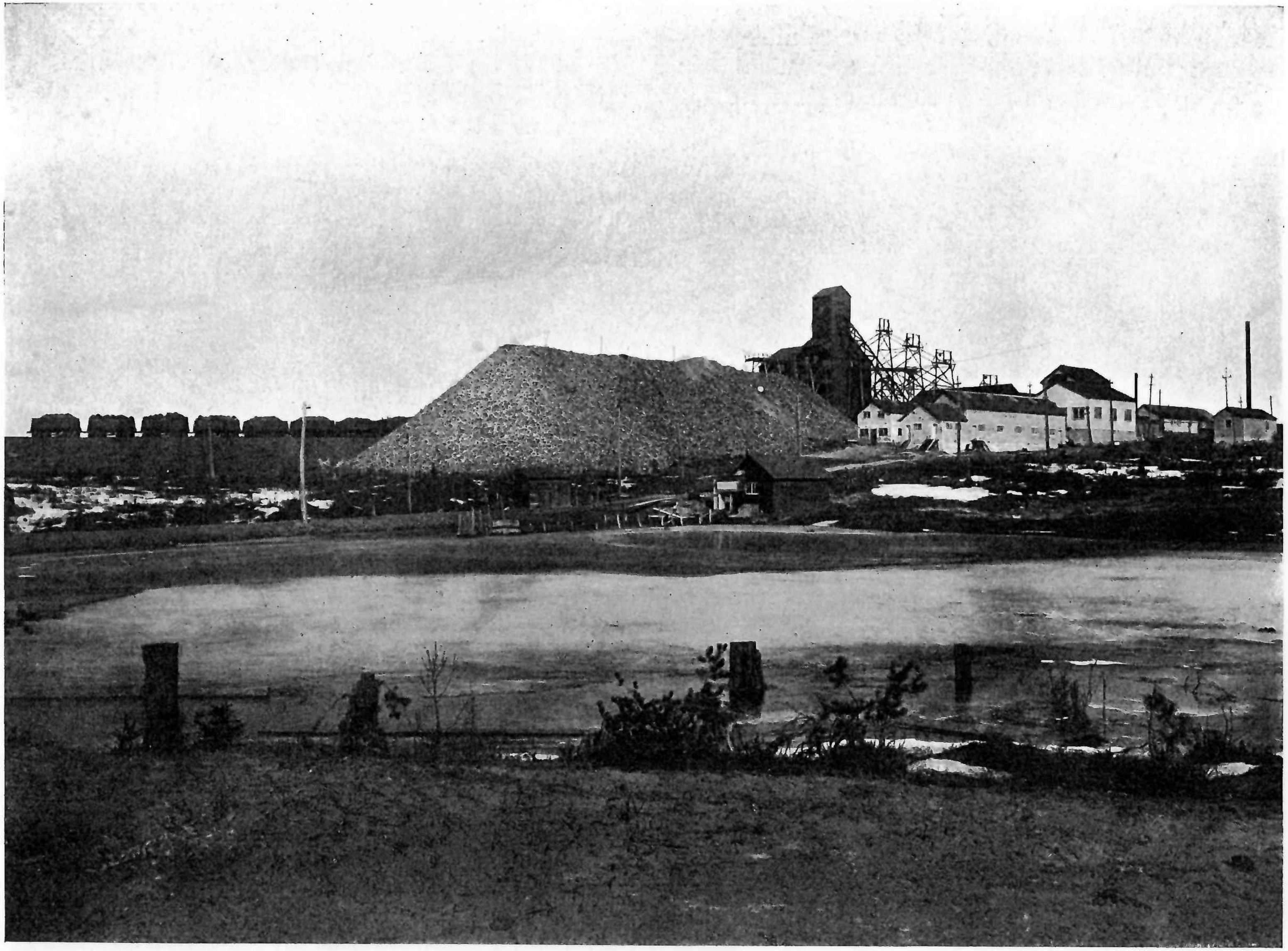
VICTORIA MINE.
ELECTRICAL HOIST.

North Star Mine

NORTH STAR MINE was worked to some extent in the years 1902-4 and 1912-14, to a depth of about 400 ft. This mine, which has now been shut down, is one of the smaller mines owned by the Company. It is situated on the Algoma Eastern Railway, which connects at Sudbury with the Canadian Pacific Railway, and shipments were made by this route to the Smelter, then situated at Victoria Mine, and later at Coniston.

North Star Mine is connected with the Company's Electric Power plant at Wabageshik.

NORTH STAR MINE.
General View of Mine Plant.



GARSON MINE.

General View of Plant.

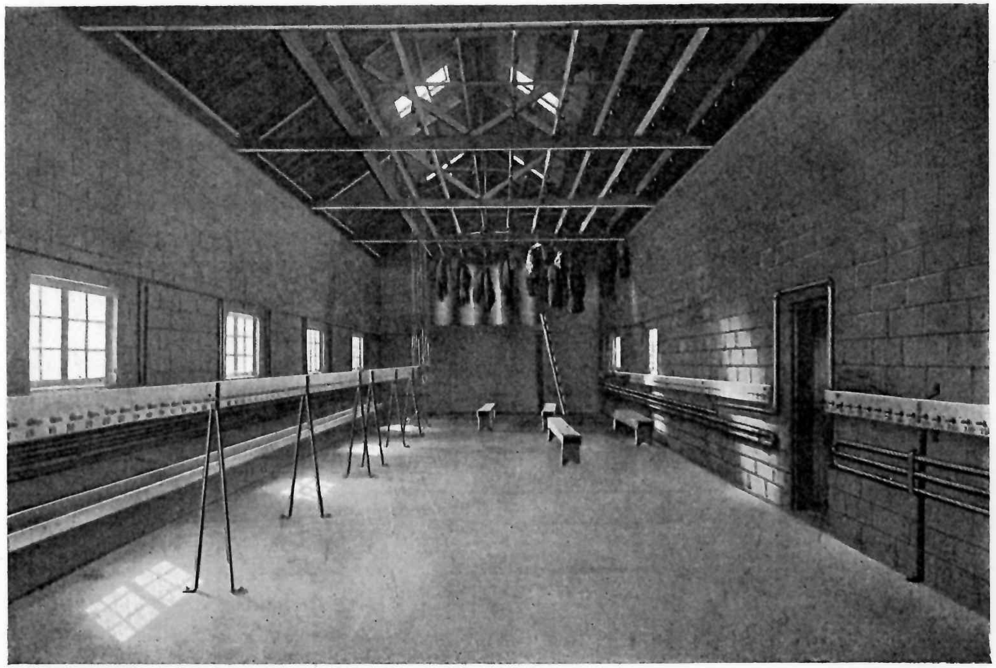
GARSON MINE

THIS mine was acquired at the same time as Victoria Mine, but it was only opened up in 1906-7. Shipments of ore began in 1908, and since then Garson has been one of the principal producers. The shaft has been sunk to 1,000 ft. The mine has been developed by eight levels, the deepest being the 1,000 ft. level. It is worked at present by one central shaft, and consists of a number of orebodies at some distance apart which appear to converge at a lower depth. The existence of ore has been proved by diamond-drilling to a vertical depth of 1,300 ft. below the surface.

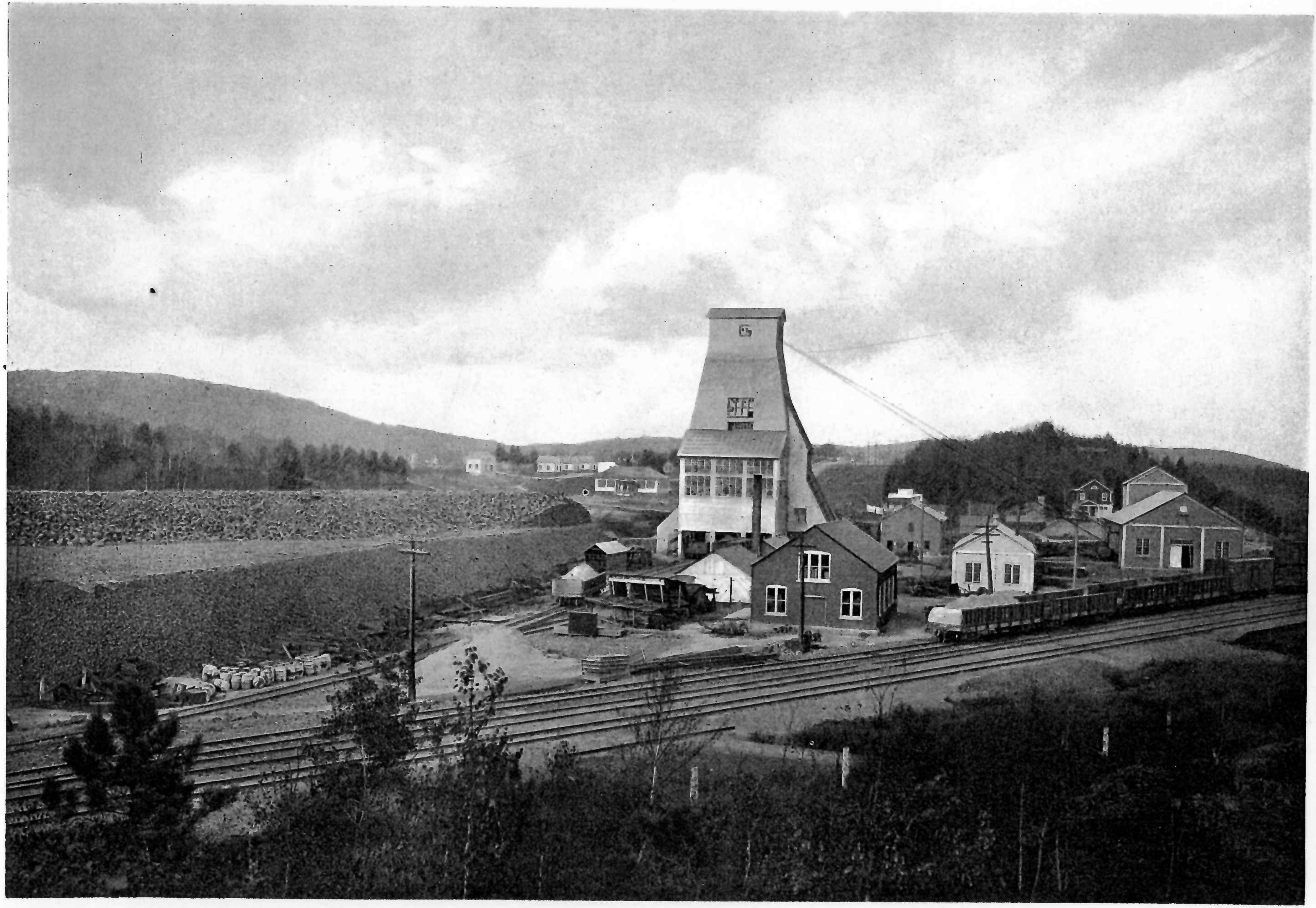
The growth of the mine has necessitated increasing the plant from time to time. The present power plant includes a transformer station, a large electric hoist, and four electrically-driven compressors, having a total capacity for seventy-two rock drills. The ore is received at the rockhouse, where it is sorted and then shipped by the Canadian Northern Railway to Coniston. The plant also comprises machine and blacksmiths' shops, warehouses and wash-houses for the workmen.

Garson Mine is connected with the Company's electric power plants at Nairn Falls and at Wabageshik by a pole-line over forty miles in length. From this source a considerable portion of its power supply is obtained, the remainder being derived from the Wahnapitæ Power Company's Plant, some seven miles distant.

GARSON MINE.
EXTERIOR VIEW OF WORKMEN'S WASH-HOUSES.



GARSON MINE.
INTERIOR VIEW OF NEW WASH-HOUSE FOR WORKMEN.



WORTHINGTON MINE.

General View of Mining Plant.

WORTHINGTON MINE

IN 1913 the Mond Nickel Company acquired all the mining properties belonging to the Dominion Mineral Company in the Sudbury district, of which the principal are the Worthington and Blezard Mines.

Worthington Mine was one of the earliest mining enterprises in the Sudbury district, having been discovered during the construction of the Canadian Pacific Railway Company's lines, near which the property is situated.

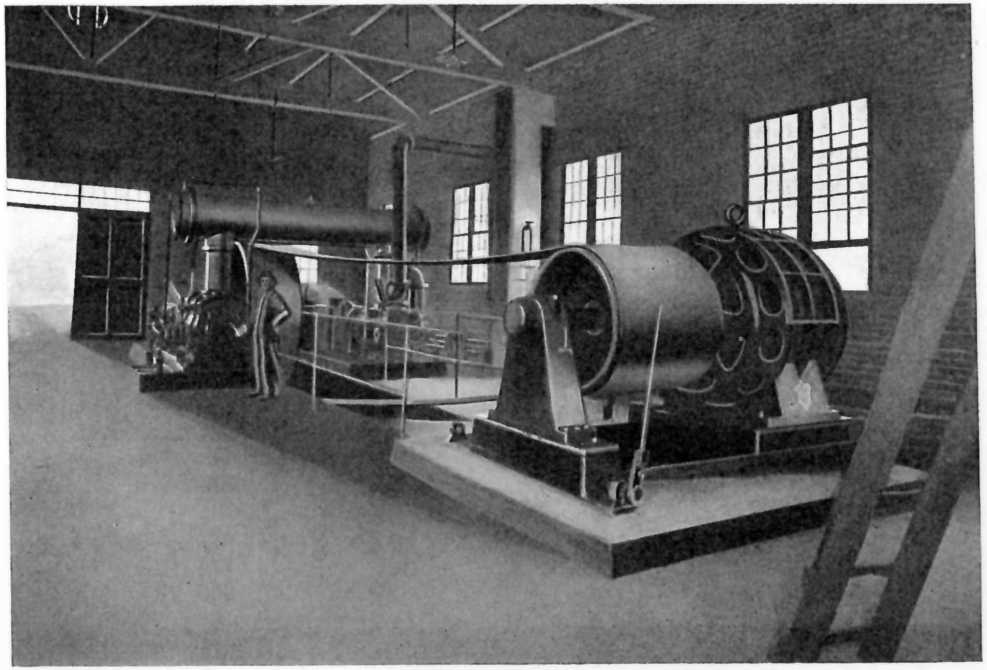
The mine was worked by the Dominion Mineral Company from 1890 to 1894, during which period 25,000 tons of ore were mined. It was shut down from that time until 1913, when it was acquired by the Mond Nickel Company, whose Mining Engineers, after extensive exploration work, located an orebody of considerable size.

A three-compartment shaft has been sunk, which is at the present time, 750 ft. deep, and levels have been driven at various depths. The continuance of the orebody to a considerable depth has been proved, and shipments from the mine are now regularly made to the Company's Smelting Works at Coniston.

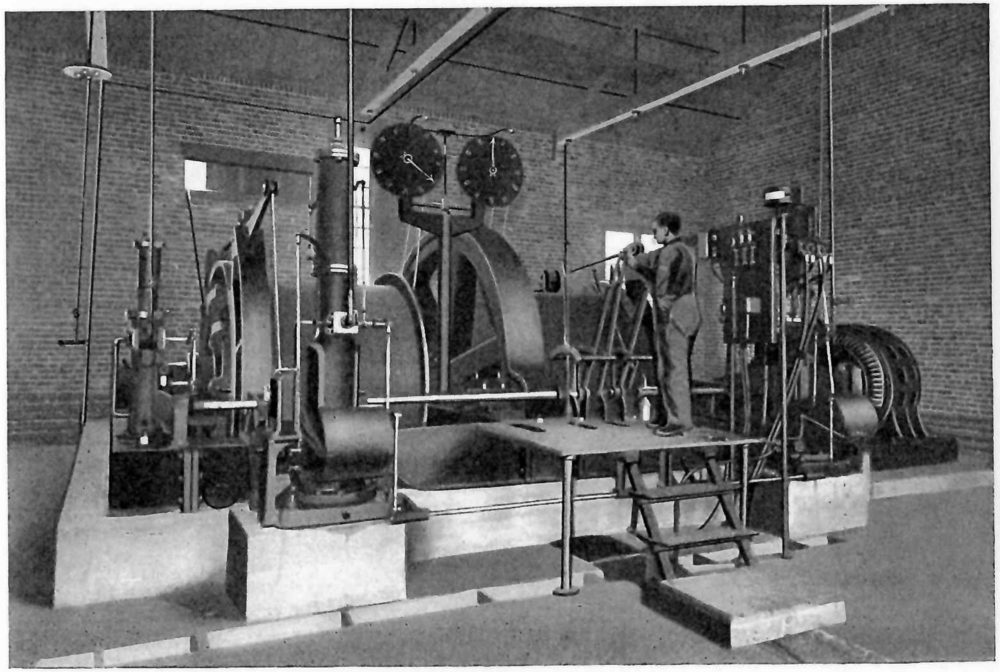
The mine has been equipped with up-to-date electric mining machinery, and the power plant includes transformers and an electrically driven hoist and compressor.

The rockhouse arrangements are, in a general way, similar to those at Garson, and include 3 Hadfield crushers and suitable picking arrangements.

The power supply is derived from the Wabageshik power plant.



WORTHINGTON MINE.
ELECTRIC COMPRESSOR.



WORTHINGTON MINE.
ELECTRICAL HOIST.

KIRKWOOD MINE

THIS is a relatively small mine, about two miles west of Garson. It has only been operated on a small scale since 1913, and 70,000 tons of ore have been mined from it.

Kirkwood Mine was connected by aerial tramway with Garson Mine, whence the ore was shipped by the Canadian Northern Railway to the Company's Smelter at Coniston. The mine is at present shut down.

LEVACK MINE.

General View of Mining Plant.

LEVACK MINES

THE Levack properties comprise three separate mines, acquired by the Company in 1913. A large amount of exploration work has been carried out at these mines by the Company. Since the acquisition of the property by the Mond Nickel Company, one of the most important nickel deposits owned by the Company has been developed in the mine known as Levack No. 1.

LEVACK No. 1

This mine is situated in Lots 6 and 7, concession 2, Levack township.

It has been connected with the Canadian Pacific Railway by a branch line, five miles long, and the Company has also constructed a railway bridge over the Onaping River.

Levack No. 1, which is one of the largest mines owned by the Company, is now in full working order, and Nickel-Copper ore of excellent quality is now being regularly shipped to the Company's Smelter at Coniston.

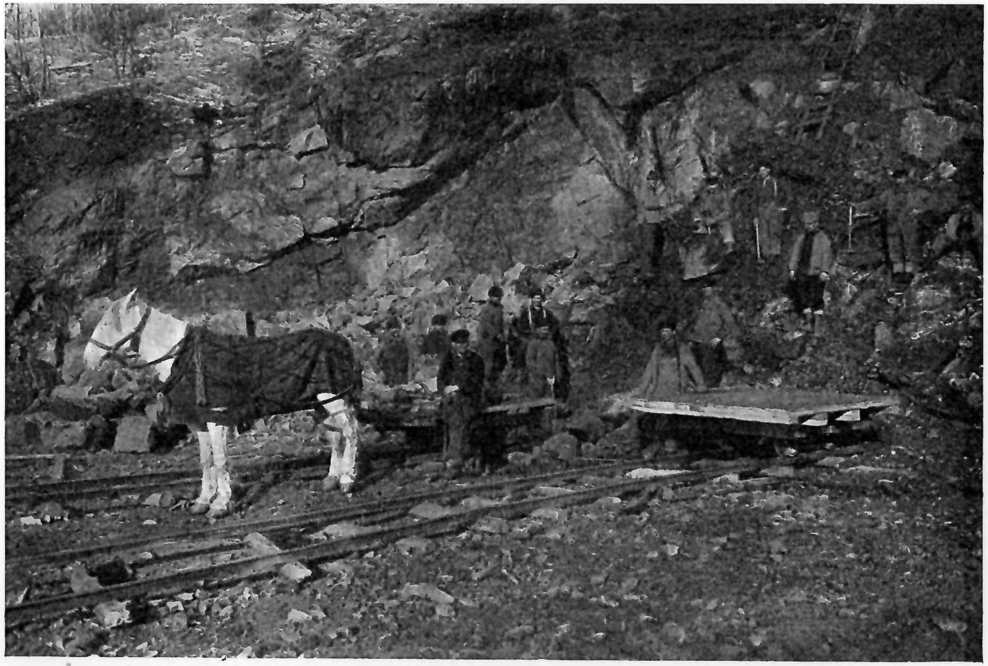
An electric transmission line, 28 miles long, delivers power, at 44,000 volts, from the Company's power plants to the mine. The mine is connected with the Company's two generating stations at Wabageshik and Nairn Falls.

The mine has been equipped with extensive, up-to-date plant and machinery. It contains an 1,800 cubic-foot Rand, compound, duplex compressor, belt-driven by a 300 h.p. motor; a 3,200 cubic-foot Ingersoll-Rand, Rogler valve, compressor, direct-driven by a 550 h.p. motor.

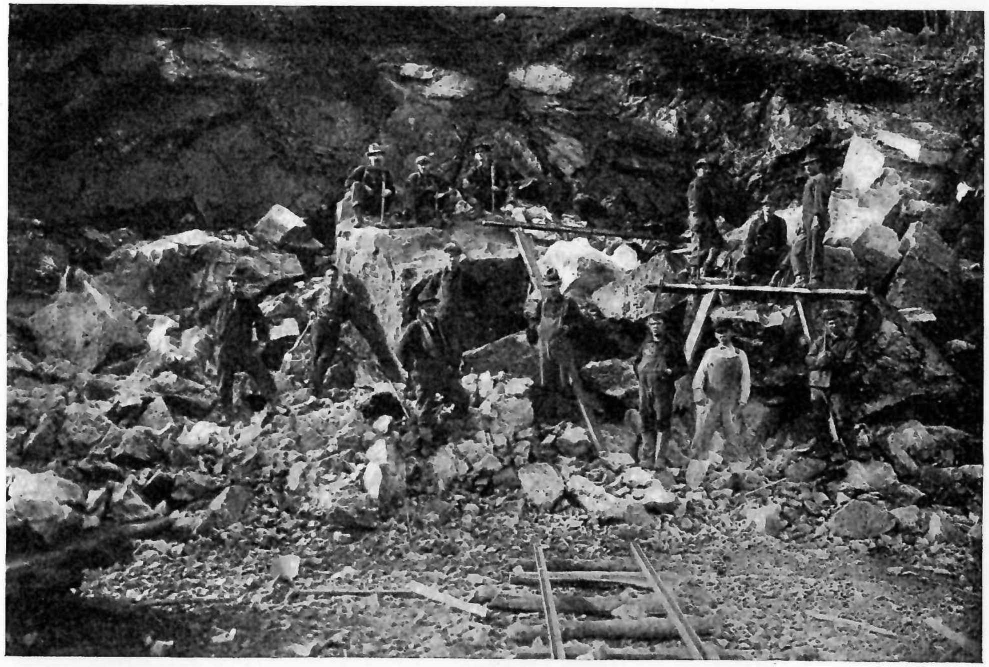
The hoist-house contains an Allis-Chalmers hoist with two cylindrical drums, 7 ft. diameter and 6 ft. face. This is capable of handling a 4-ton load in the skip, and is driven by a specially-designed Allis-Chalmers motor of 250 h.p.

A five-compartment inclined shaft has been sunk to the seventh level, 590 ft. deep, measured vertically.

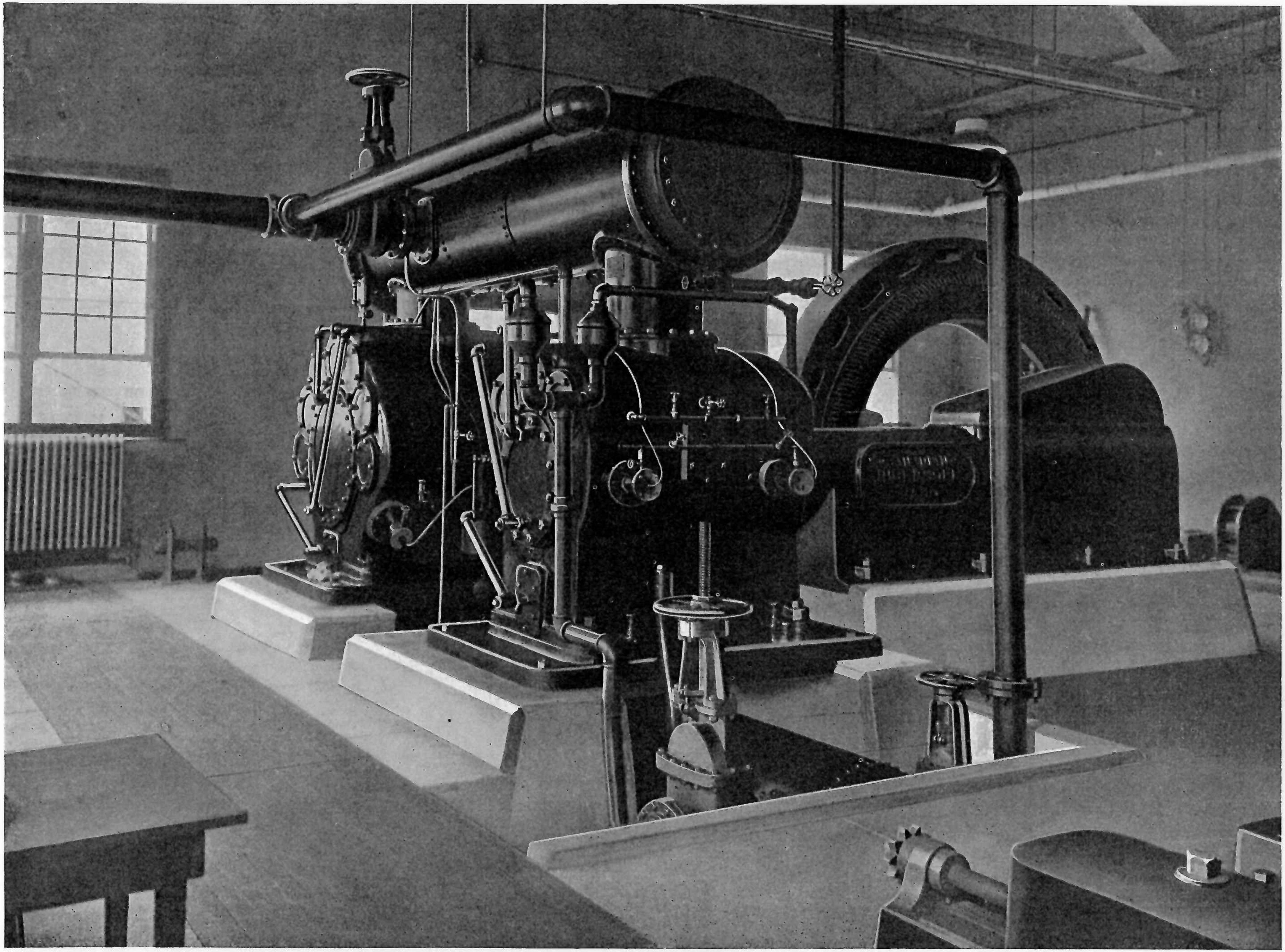
The ore has been developed in five levels, and has been proved to a depth of 1,400 ft. Very extensive exploration and development work has been carried out by the Company, which has disclosed large orebodies of good ore, estimated by the Company's engineers at from 6,000,000 to 8,000,000 tons.



LEVACK MINE.
BREAKING SURFACE ORE.



LEVACK MINE.
BREAKING LARGE BLOCKS OF ORE IN AN OPEN CAST.



LEVACK MINE.

INTERIOR VIEW OF POWER HOUSE, SHOWING DIRECT CONNECTED MOTOR-DRIVEN AIR COMPRESSOR.

Bruce Mines

THESE mines were acquired by the Mond Nickel Company in 1915. They are Copper Quartz mines. Copper Quartz is used by the Company at the Smelting works at Coniston as flux in the converters. Bruce Mines are situated on the main line of the Canadian Pacific Railway Company, on the north shore of Lake Huron. The orebodies occur in the Nipissing Diabase and consist of Quartz veins containing Chalcopyrite.

Blezard Mine

BLEZARD Mine was worked by the Dominion Mining Company from 1889 to 1893, when the orebody gave out. During this period the production of ore from the mine was about 100,000 tons. The open pit was 60 ft. deep, but the lower workings of the mine reached a depth of 172 ft.

Since the Mond Nickel Company acquired this property a considerable amount of exploration work has been carried out. The mining engineers came to the conclusion that the orebody of the mine was cut off by a dyke, and they have since discovered the continuance of the orebody west of the dyke and proven its continuation to a depth of about 1,000 ft.

It is not the intention of the Mond Nickel Company to open up this mine at present.

Frood Extension Mine

THIS mine was purchased in 1911, and at the end of that year a four-compartment shaft 21 ft. by 7 ft., was started. In 1914, the shaft reached a depth of 1,005 ft., at about which depth the main orebody lies.

Three stations have been cut, at 400 ft., 750 ft., and 900 ft. respectively.

The plant comprises the most modern mining equipment, as the bulk of the Frood Extension ore lies at a much greater depth than that in any of the other mines of the Company.

The power-house has been completed, its equipment comprising the following machinery:—

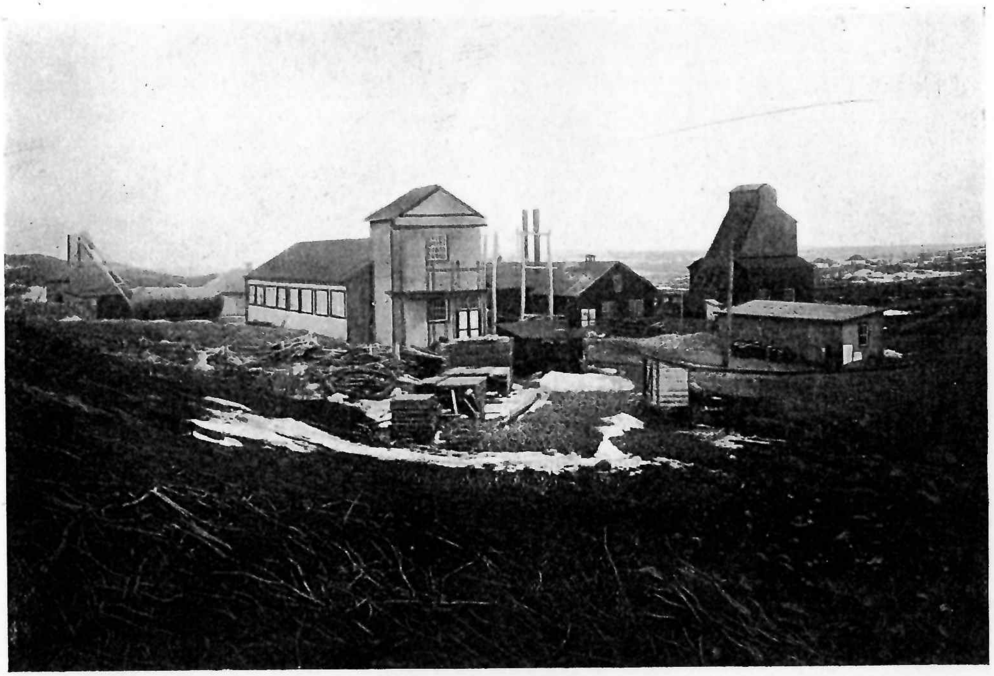
One 23 in. and 23 in. by 48 in. Nordberg geared hoist with two drums, 10 ft. in diameter with 78 in. faces. It is equipped for either air or steam. Provision has been made whereby a third clutched drum, for hoisting workmen, may be added when desired.

One 2,800 cubic ft. Nordberg air compressor.

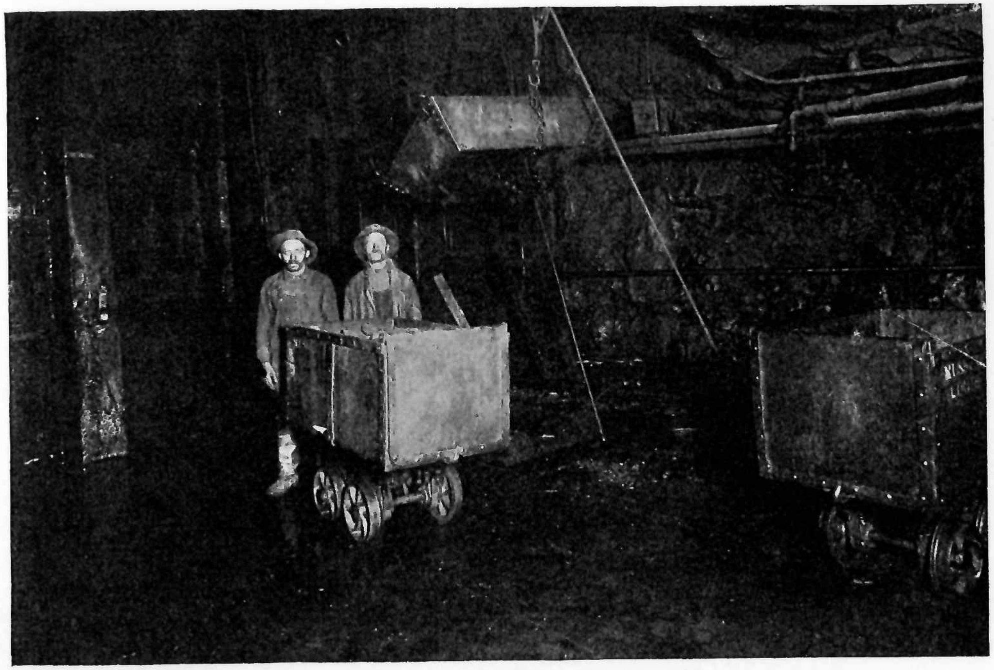
One 1,750 cubic ft. Rand air compressor, belt driven.

The construction of the rockhouse and dry was in progress when the shut-down occurred at the beginning of the war, at which time Mr. J. H. Stovall was superintendent, and from 100 to 145 men were employed.

Diamond drilling, which is still in process, has already indicated that Frood Extension will be a very large and important mine.



FROOD EXTENSION MINE.
POWER HOUSE AND TEMPORARY ROCK HOUSE.



FROOD EXTENSION MINE.
STATION AT 750 ft. LEVEL.

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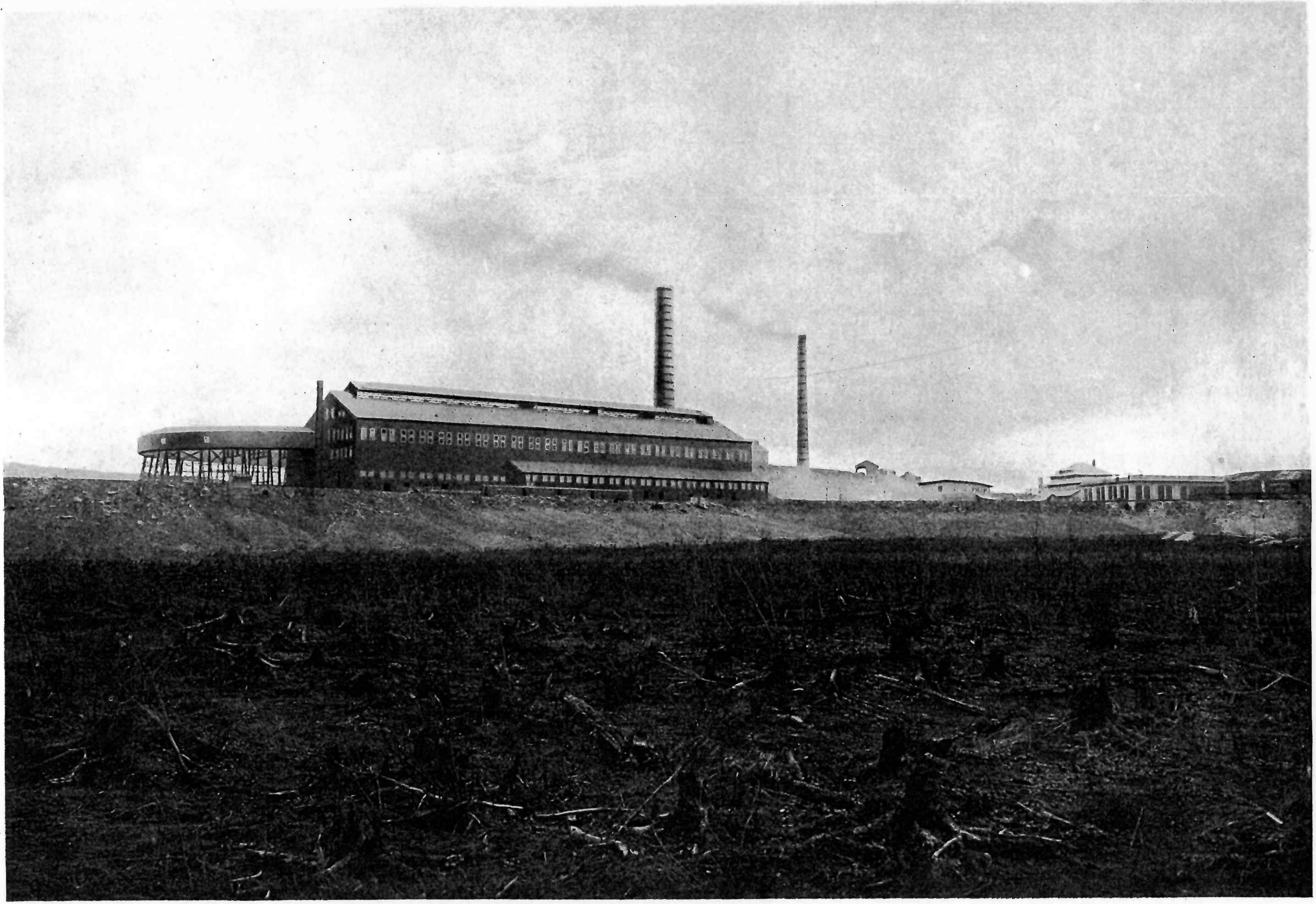


CONISTON SMELTER.

General View.

CONISTON SMELTER

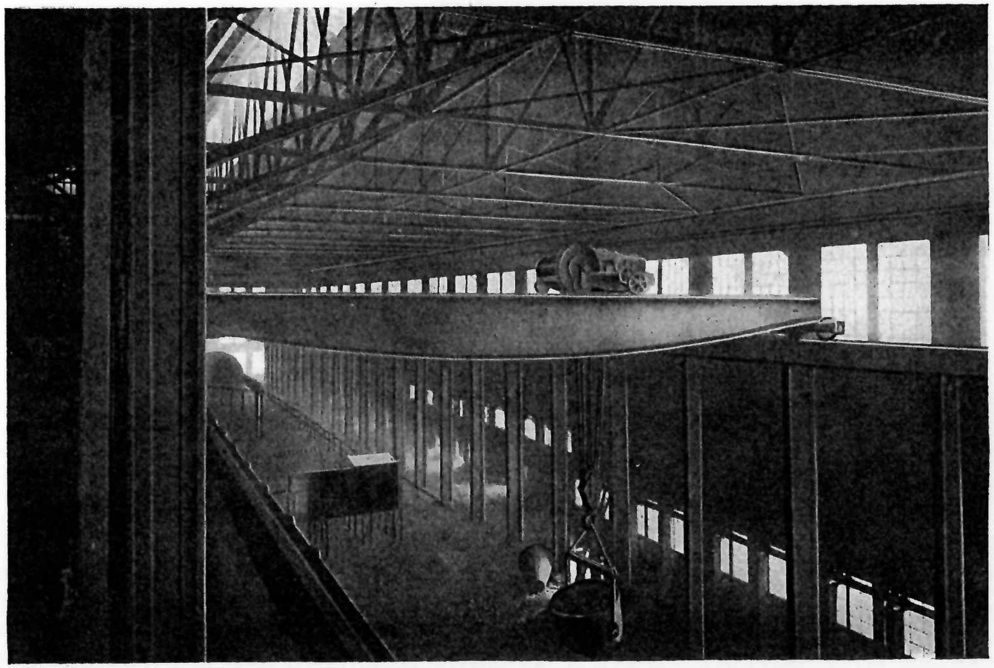
ORIGINALLY, the Mond Nickel Company, Limited, carried on its smelting operations at Victoria Mine Smelter; indeed, as recently as June, 1909, the plant was remodelled for electric power. But the increase in the tonnage of ore to be smelted was so rapid that, in 1911, it was decided to abandon Victoria Mine Smelter, and to erect new smelting works at Coniston, a site which, both geographically and topographically, is almost ideal.

Coniston lies eight miles east of Sudbury, at a junction of three railways, in a district consisting chiefly of low rocky hills. It is on the main line of both the Canadian Pacific Railway and the Canadian Northern Railway, and is also served by the Toronto Branch of the Canadian Pacific Railway, which joins the main line a little further west. These railways afford direct connection with all the Company's mines in the district.

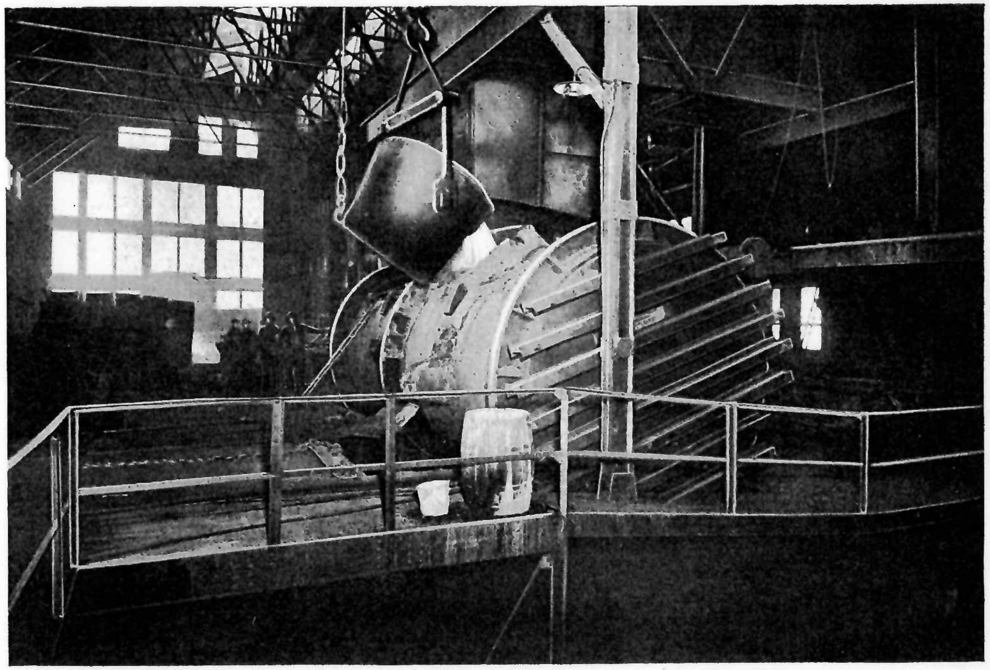
The ore and other materials are received from the Canadian Pacific Railway and the Canadian Northern Railway in standard gauge cars, which are self-dumping and of fifty tons capacity. Sintered and roasted ore is delivered to the Smelter bins in similar cars owned by the Company. The Company operates its own steel bottom-dump fifty-ton ore cars, flat cars, slag cars, and locomotives, as well as two switching engines. There are about ten miles of railway track of standard gauge (rails 80 lbs. per yard) owned by the Company.

The Coniston Plant consists of a Sintering Department, containing two Dwight Lloyd straight line sintering machines, a Roastyard of 120,000 tons capacity, a Smelting Department with four modern 50 by 240 inch blast furnaces, and a Converting Department with four Pierce-Smith basic converters, 25 ft. 10 in. long by 10 ft. in diameter.

The Sintering Plant agglomerates the fine ores and flue dust into a product suitable for blast furnace smelting and low in sulphur content.



CONISTON SMELTER.
ELECTRIC TRAVELLING CRANE OVER CONVERTER FLOOR.



CONISTON SMELTER.
CONVERTOR RECEIVING FURNACE MATTE.

Whatever further preliminary sulphur elimination is necessary is accomplished by roasting coarse ore at the Roastyard. Practice is progressing steadily in the direction of the elimination of heap roasting. Successful operation without the use of roasted ore has been carried out at Coniston, and this will probably be future practice.

The main constituent of the charge fed into the smelting furnaces is coarse crude ore, the balance being made up of sintered fine ore, roasted ore, limestone, coke, and any metal-bearing scrap made while handling intermediate products. These materials are delivered to the smelter bins in cars of 4,000 lbs. capacity hauled by electric locomotives. Each furnace has thirty-two $4\frac{1}{2}$ in. tuyeres, through which air is blown at 35 to 45 oz. pressure.

The ore is concentrated in the blast furnaces, into a matte containing the Nickel and Copper, and part of the Iron in the form of Sulphide. Most of the Iron and the rocky matter in the ore are converted into slag. The molten matte and slag flow from the bottom of the furnace into a large settler lined with chrome brick. Here a separation is obtained, the matte containing the Copper and Nickel settling to the bottom, while the slag floats on the top and is allowed to overflow to waste. The operation is continuous. Furnace matte is drawn off from a tap-hole at the bottom of the settler from time to time. Each furnace is capable of smelting from 400 to 500 tons of ore per day.

The furnace matte is run from the settlers into ladles of about ten tons capacity, and these are lifted by electric travelling cranes. The matte is then poured molten into the converters. These are lined with basic brick. Each holds about forty tons of matte. Through this molten matte about 7,000 cubic feet of air is blown per minute. The Iron and Sulphur are oxidised, the Sulphur dioxide passing off as a gas and the Iron dioxide being made into an easily fusible slag by the addition of silicious copper ores.

The final result is a Bessemer Matte containing about 41% of Copper, 41% of Nickel, 17% of Sulphur, and less than 1% of Iron. This is poured molten into ladles and thence into moulds, where it solidifies. It is then crushed and barrelled, and is ready for shipment to the United Kingdom.

It might be mentioned here that the Mond Nickel Company was the first in the Sudbury district to make a commercial success of using Bessemer converters for the concentration of Blast Furnace Matte into Bessemer or Concentrated Matte, containing 80-82% of metals, the practice in the Sudbury district having been, heretofore, to make Blast Furnace Matte containing 20-26% Copper-Nickel.

The magnitude of the Smelting Plant is graphically illustrated by the photographs, which show :—

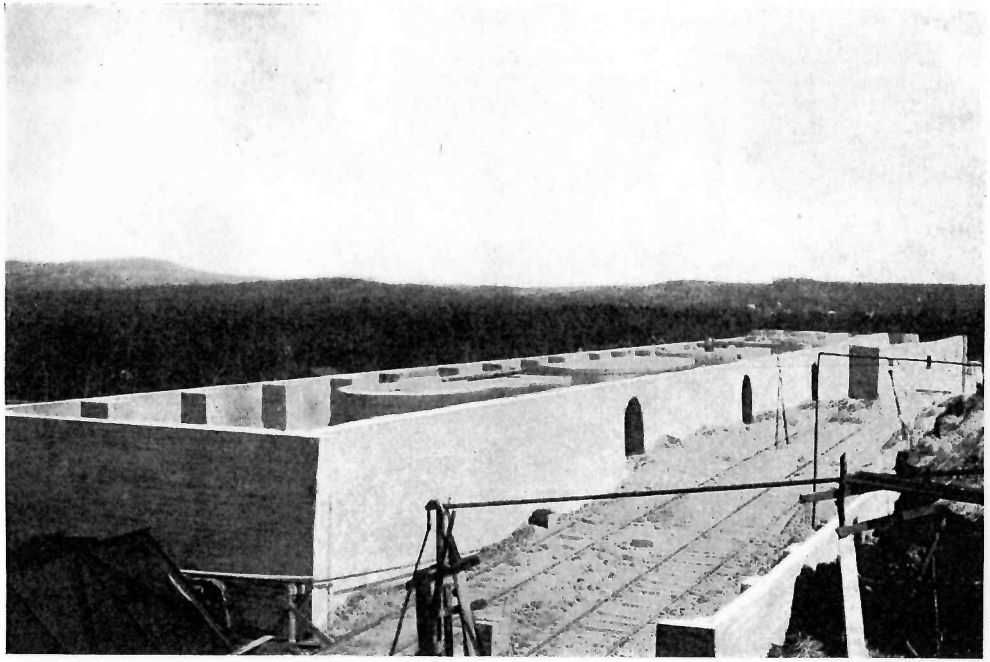
1. Site of the Works before Erection. September, 1911.
2. Foundations of the Plant. June, 1912.
3. Works in course of erection. October, 1912.
4. Works nearing completion. December, 1912.

Great credit is due to the Company's management and Engineering Staff for the laying-out, design, and erection of the magnificent Works at Coniston.

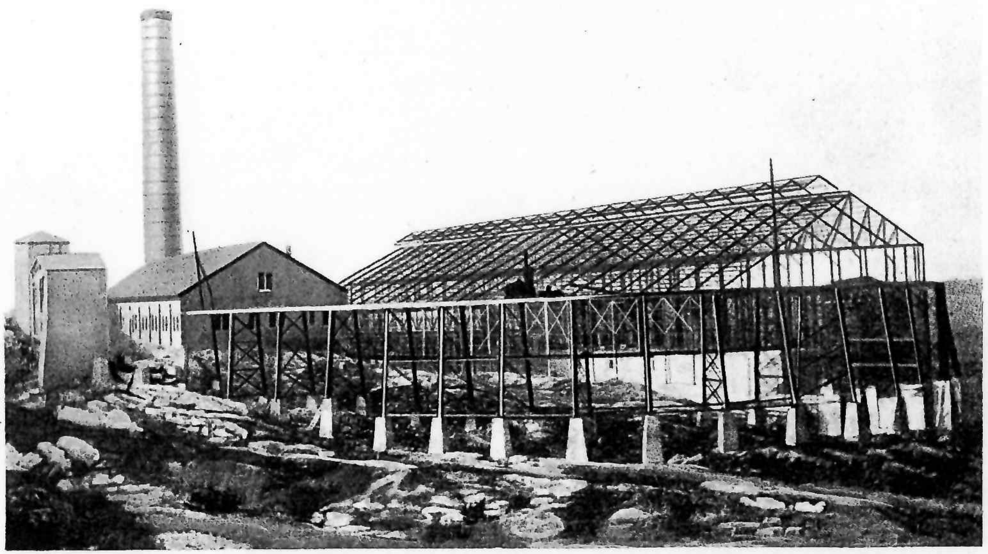
The following is a list of the chief officers of the Company in Canada :—

Manager	C. V. Corless.
Mines Superintendent	O. Hall.
Local Mine Superintendents—	
Levack Mine	F. J. Eager.
Garson Mine	J. R. Thoenen.
Worthington Mine	R. N. Palmer.
Victoria Mine	W. J. Mumford.
Bruce Mine	A. D. Carmichael.
Exploration Engineer	V. P. Row.
Superintendent of Reduction Works	J. F. Robertson.
Smelter Superintendent	E. T. Austin.
Mill and Sintering Plant Superintendent	K. S. Clarke.
Chief Chemist	T. M. Paris.
Chief Engineer	W. L. Dethloff.
Mechanical Superintendent	F. G. Herman.
Electrical Superintendent	W. H. Soule.
Power Plant Superintendent	George Hillyard.
Chief Draughtsman	R. J. McKay.
Cashier and Chief of Office Staff	W. A. McDonell.
Chief Accountant	J. A. Ross.
Purchasing Agent	F. Simms.
Agricultural Expert	J. Laughland.

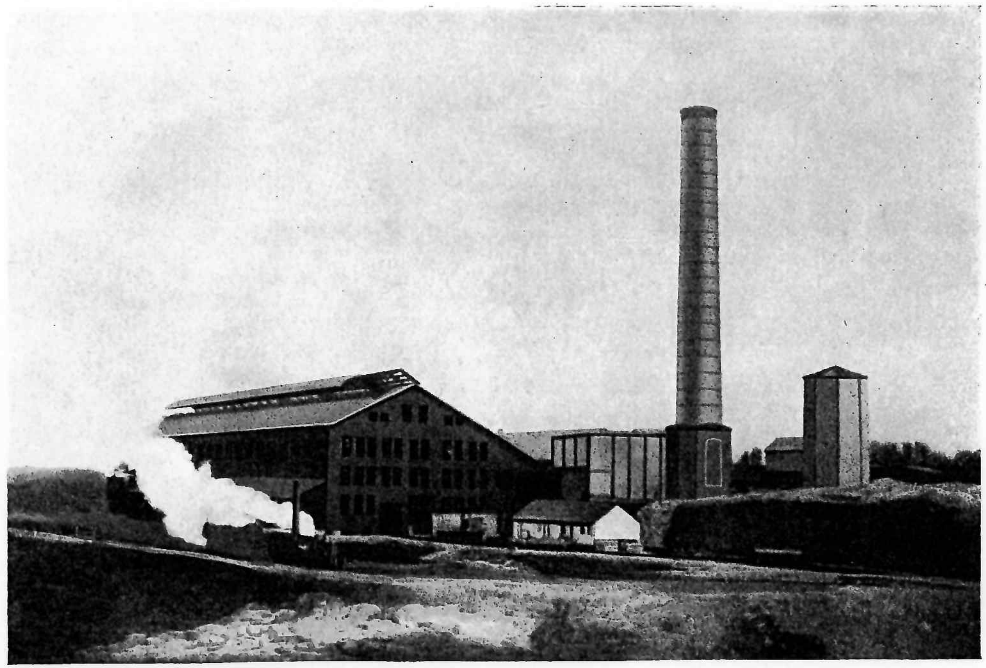
CONISTON SMELTER SITE BEING CLEARED.
SEPTEMBER, 1911.



A PART OF THE FOUNDATIONS OF CONISTON SMELTER.
JUNE, 1912.

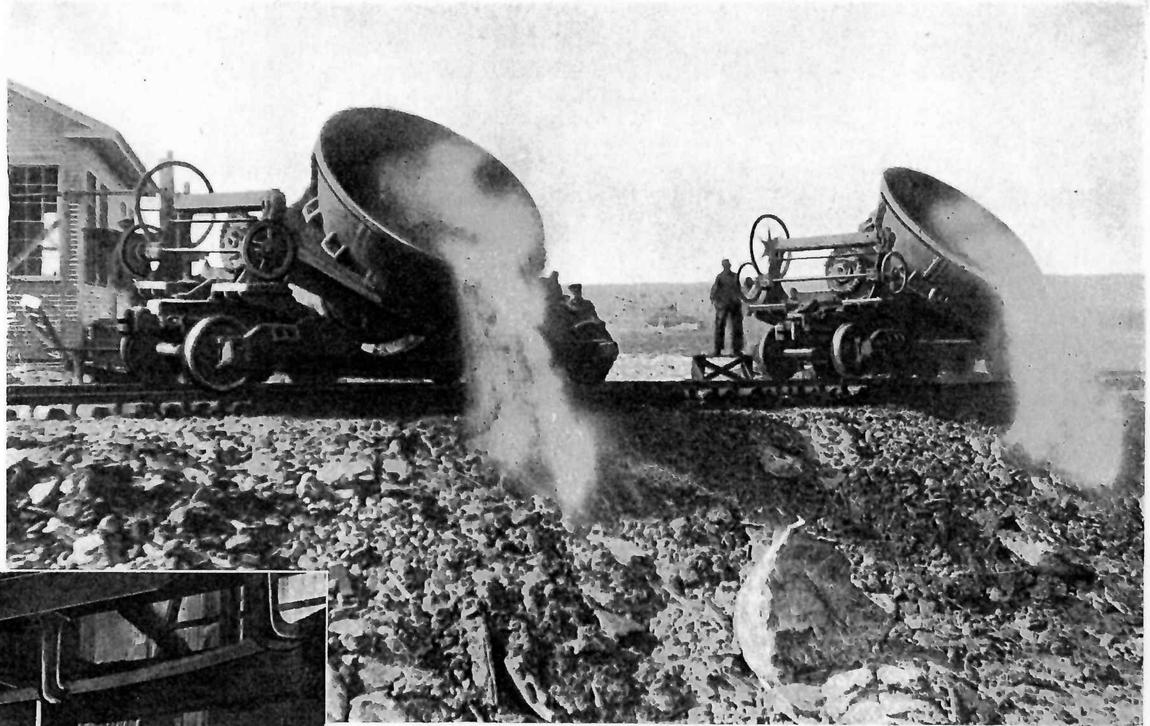


CONISTON SMELTER IN COURSE OF ERECTION.
OCTOBER, 1912.

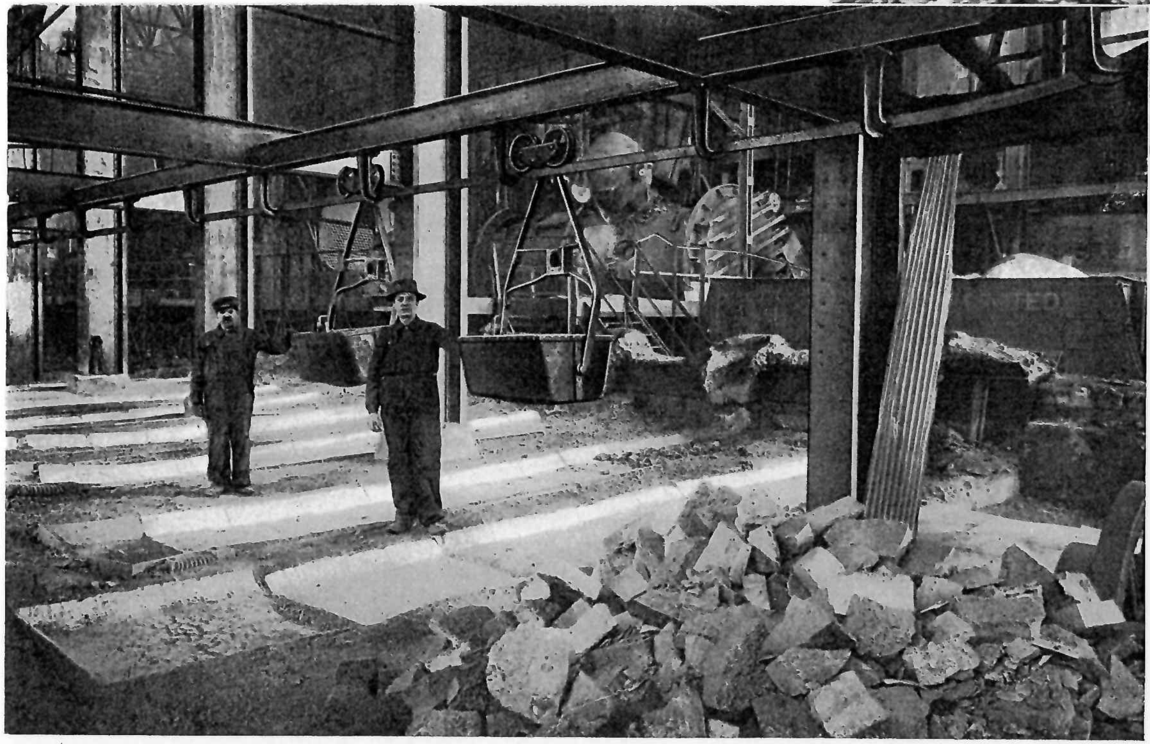


CONISTON SMELTER NEARING COMPLETION.
DECEMBER, 1912.

Coniston Plant

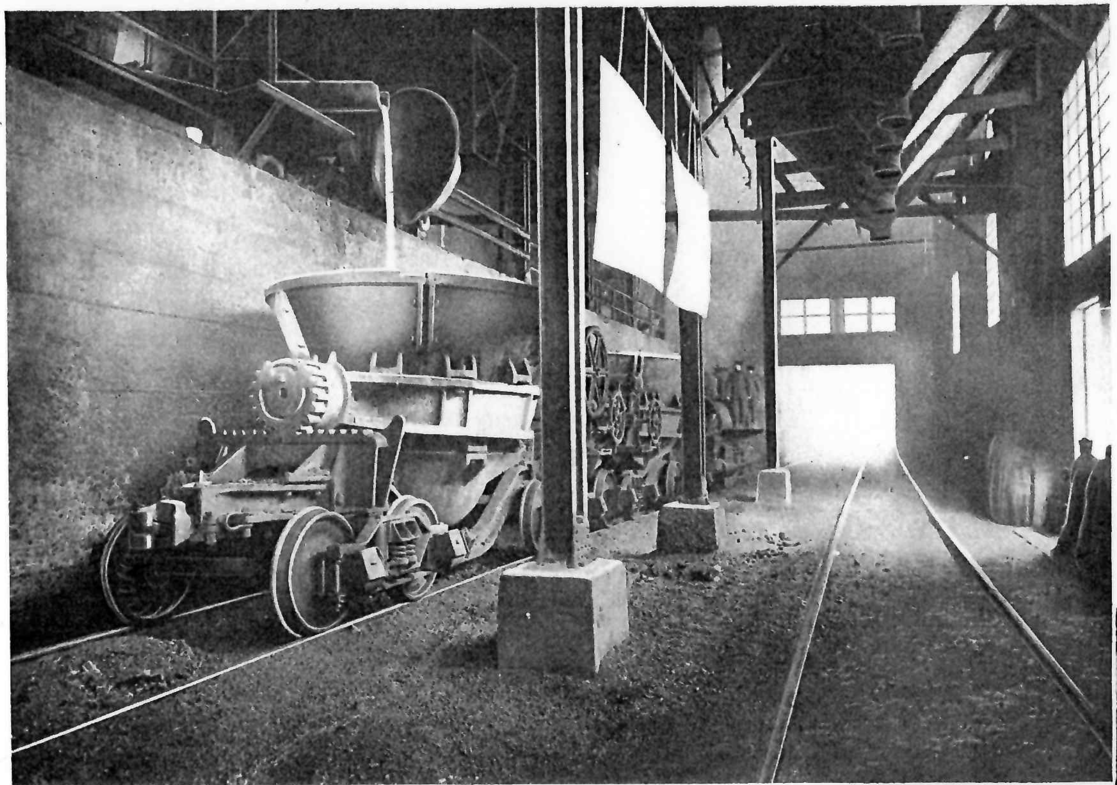


CONISTON PLANT.
Dumping Slag Cars.

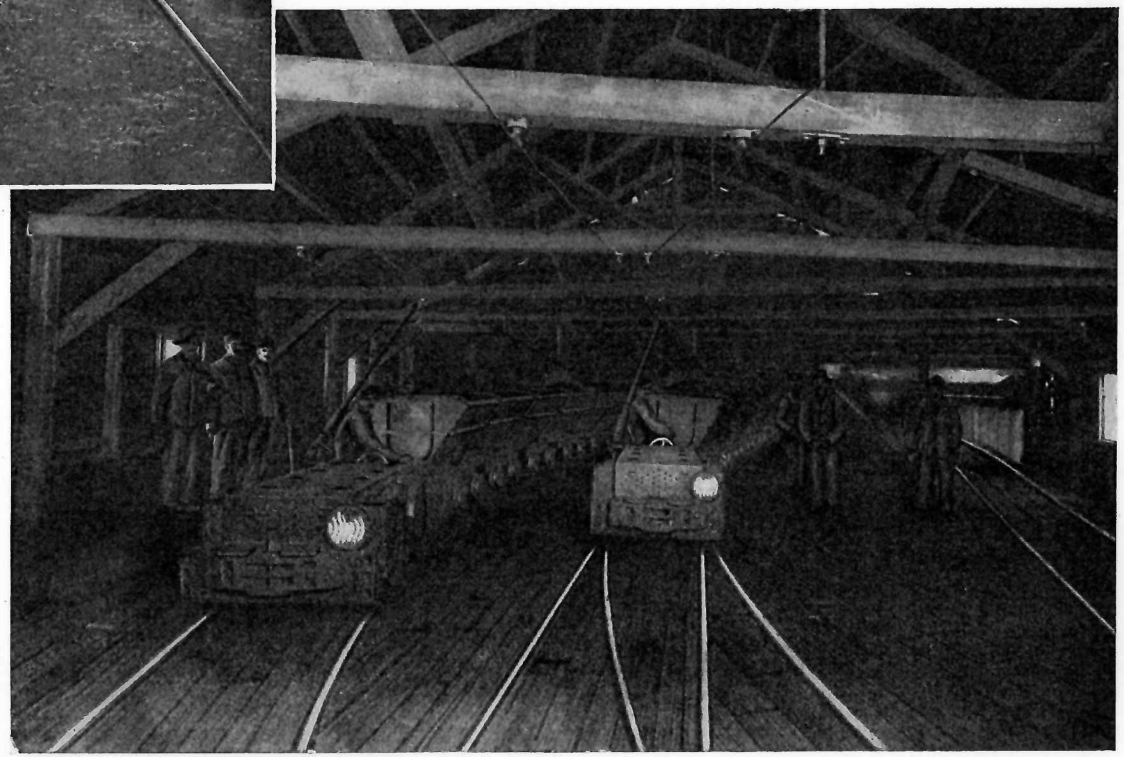


CONISTON PLANT.
Bessemer Matte Moulds in Smelter.

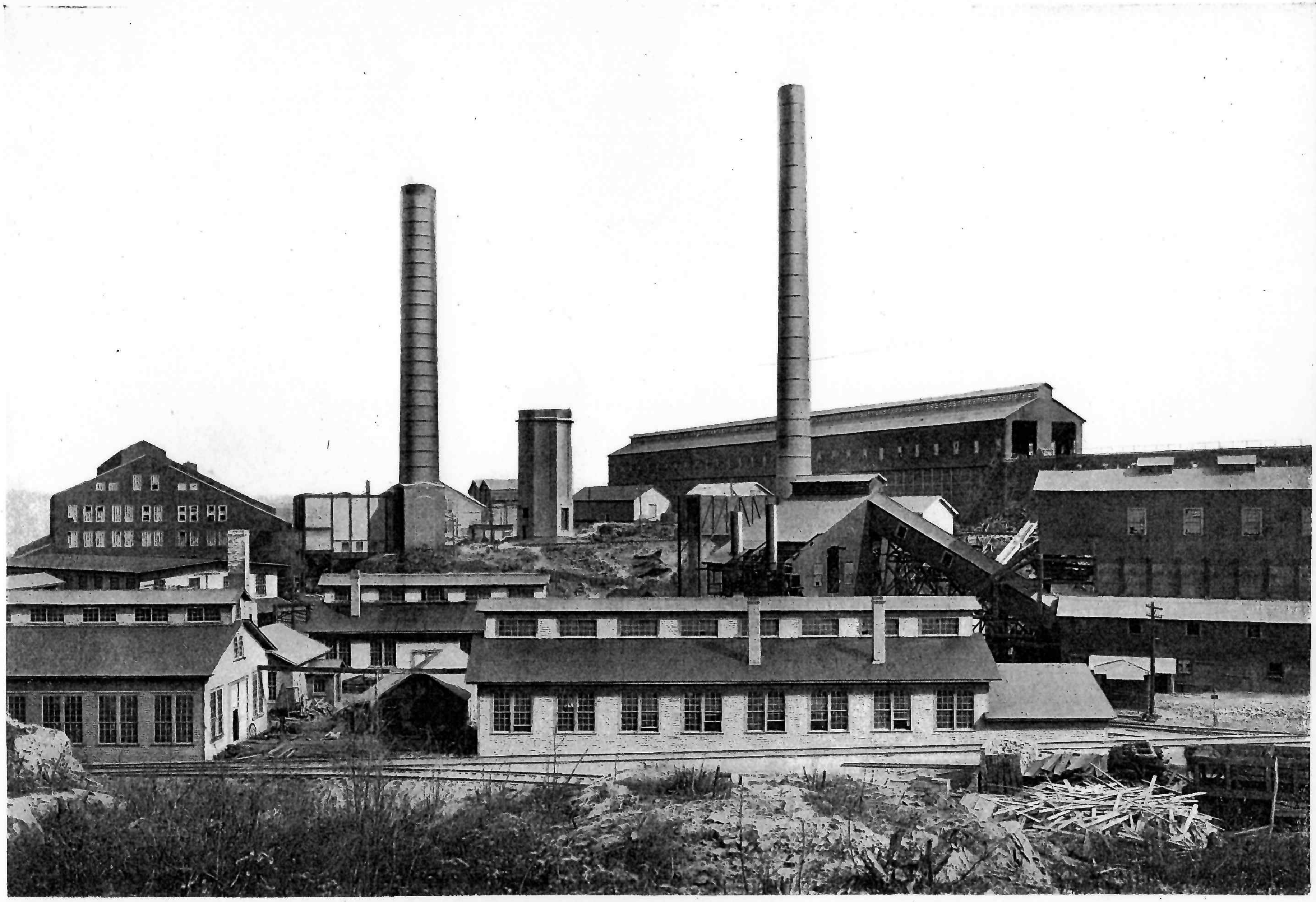
Coniston Plant



CONISTON PLANT.
Train of Cars being conveyed by Loco. to Slag Dump.

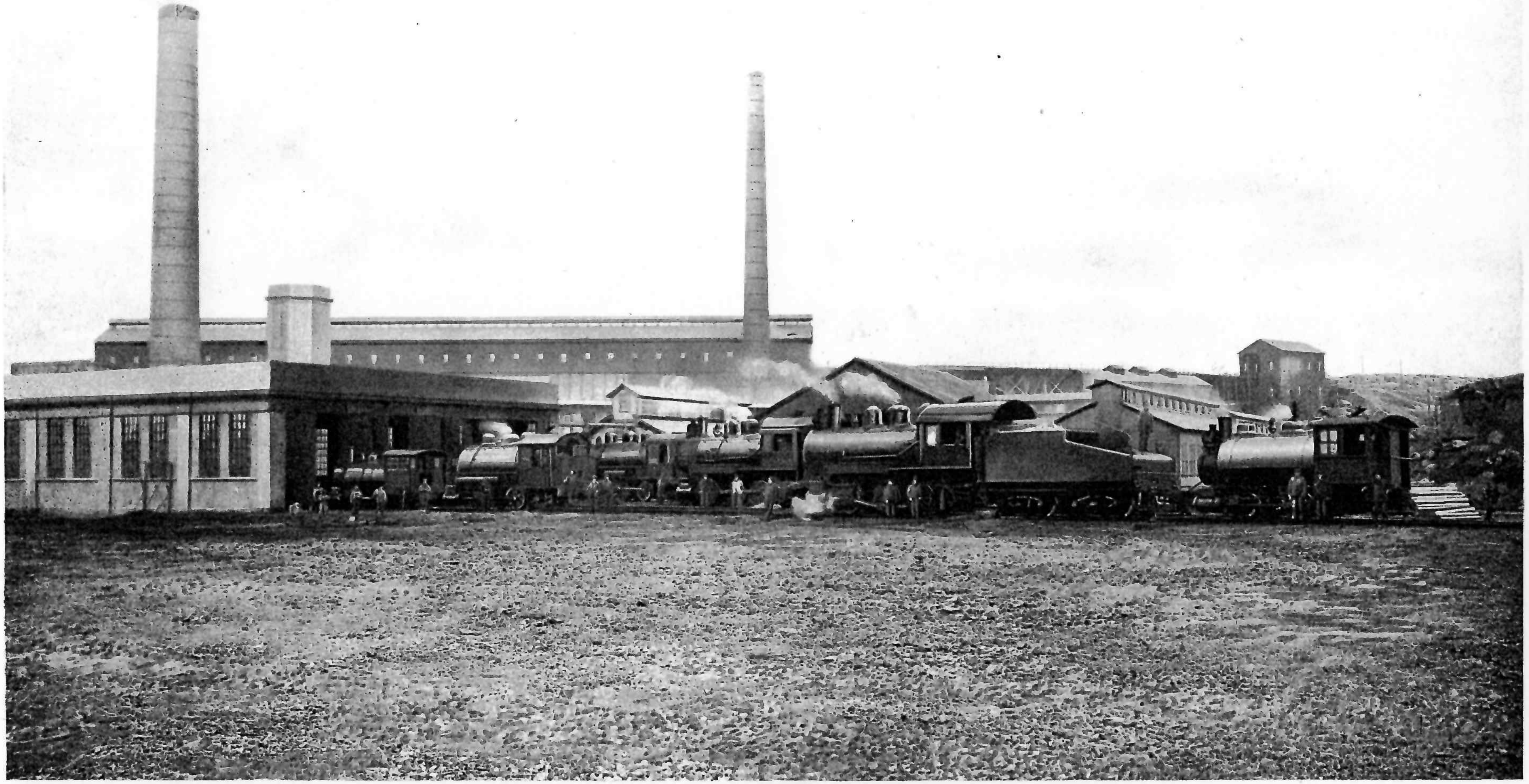


CONISTON PLANT.
Charging Trains leaving Smelter Bins.



CONISTON SMELTER.

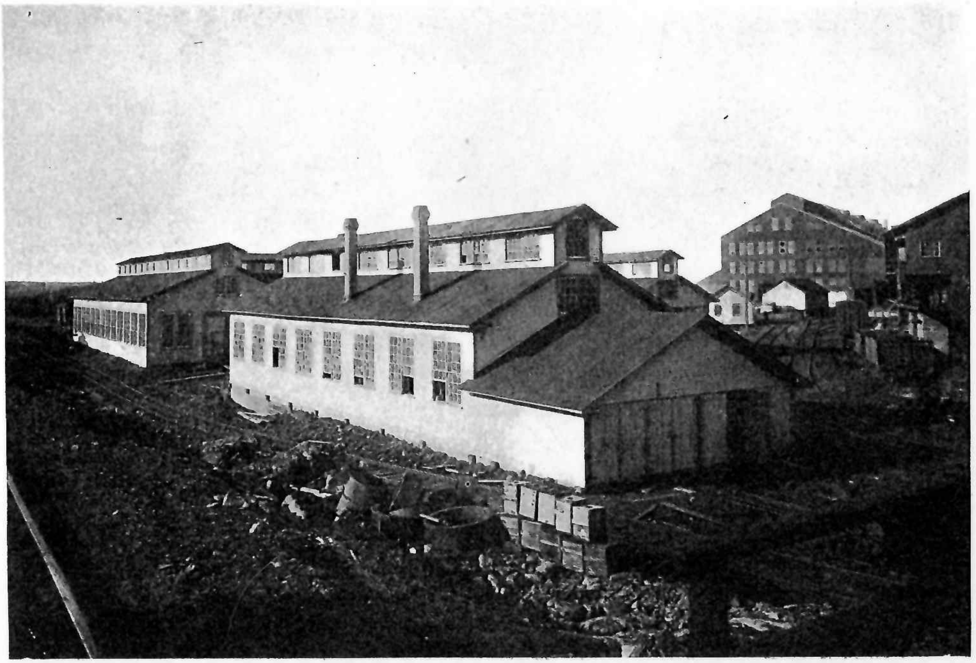
General View of Smelting Works, showing Sintering Plant, Ore Bins, and Part of Shops.



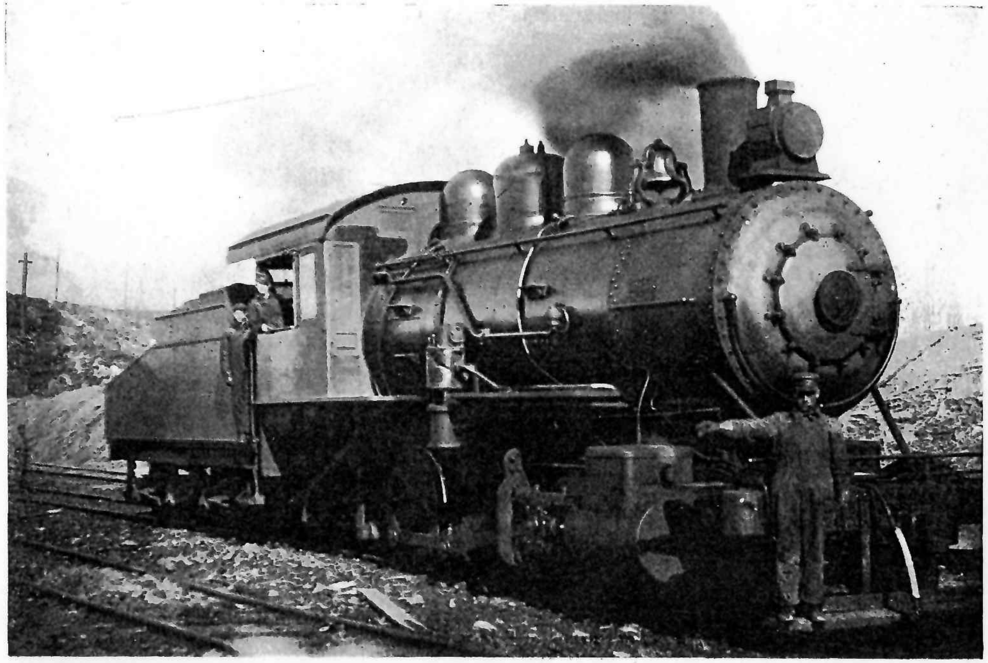
LOCOMOTIVES AT ROUND HOUSE DURING LUNCH HOUR.

WATER SUPPLY

WATER is obtained from the Wahnapitæ River, and is pumped to a tank of 160,000 gallons capacity at the Smelter through 6,000 ft. of 10 in. steel pipe. Duplicate turbine pumps are installed in a concrete pump-house 24 ft. by 26 ft. Each pump is capable of delivering 1,500 gallons per minute against a head of 500 ft. The pumps are connected direct to 300 h.p. electric motors. Coniston village is supplied by a 6 in. branch from the 10 in. line. Pump-pressure is constantly available in case of fire, the house services being taken from pressure-reducing valves.



CONISTON PLANT.
BLACKSMITH'S SHOP, MACHINE SHOP, ETC.



CONISTON PLANT.
LOCOMOTIVE AND TENDER. TOTAL WEIGHT, ONE HUNDRED AND THIRTY TONS.

Power House

THE Power House building is 72 feet by 120 feet in size, with concrete foundations resting on rock, structural steel frame and trusses for supporting the roof, the walls are brick, the roof reinforced concrete tile, and the floor steel plate supported on steel girders and columns.

Attached to one corner is a transformer house, 36 feet by 24 feet, and along one side is the switchboard extension, 16 feet by 84 feet, all built of the same material.

Power is received from the Wahnapitæ Power Company at 16,000 volts, three-phase alternating current, and from the Lorne Power Company at 47,000 volts, three-phase alternating current, and is transformed to 550 volts, all machinery being connected by double-throw switch to the two sets of bus bars.

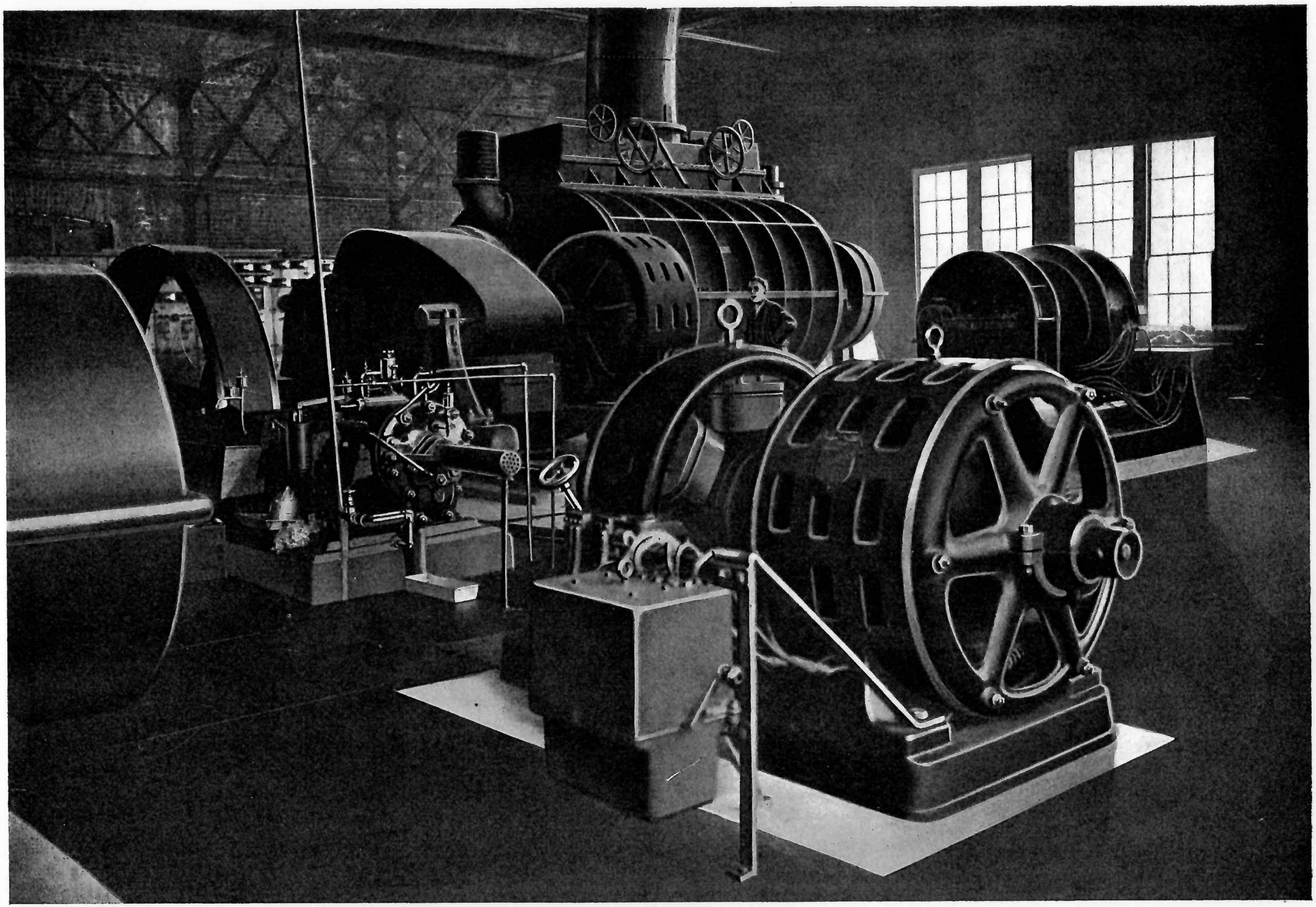
For supplying air to the blast furnaces at about 40 ounces pressure, there are installed two 200 H.P. induction motors, one with three speeds driving two Connersville Blowers, each of 17,700 cu. ft. per minute capacity, two Connersville Blowers, each of 54,000 cu. ft. capacity, one driven by two 300 H.P. induction motors through silent chain belts, and the other is driven by two 300 H.P. Synchronous motors through Herringbone Gear Reduction.

A Rateau low-pressure turbo-blower of 65,000 cu. ft. capacity, direct connected to induction motor, is being installed.

Two Nordberg Blowing Engines, driven by 500 and 315 H.P. induction motors respectively, supply 10,000 and 7,500 cu. ft. of air, and one Rateau turbo-blower, direct connected to a 1,250 H.P. induction motor, supplies 23,000 cu. ft. air per minute, all at eleven pounds per square inch pressure, to the Converters.

Air for pneumatic tools and power hammer, etc., is provided by 200 H.P. motor, driving a 1,200 cu. ft. Compressor, and one 75 H.P. motor, driving a 360 cu. ft. Compressor at 100 lbs. pressure.

For electric lighting the Reduction Works and power for shops, electric charging locomotives, electric travelling cranes, and a number of small motors, current is supplied by two motor Generators of 100 and 150 kilowatts capacity.



CONISTON POWER HOUSE.

INTERIOR VIEW, SHOWING 400 CU. FT. BLOWER AND MOTOR GENERATOR SETS.

CONISTON PLANT

CONISTON OFFICE.
CANADIAN GENERAL OFFICE OF THE MOND NICKEL CO., LTD.

GENERAL VIEW OF CONISTON SMELTER AND VILLAGE.

POWER PLANTS

THE Company's Mines and Smelters were at first operated by a steam plant at Victoria Mines. Owing, however, to the great increase in the power requirements of the Company, it was decided in 1907 to employ electricity instead of steam for purposes of power, and the Mond Nickel Company's Mines and Reduction plants are, therefore, now operated electrically.

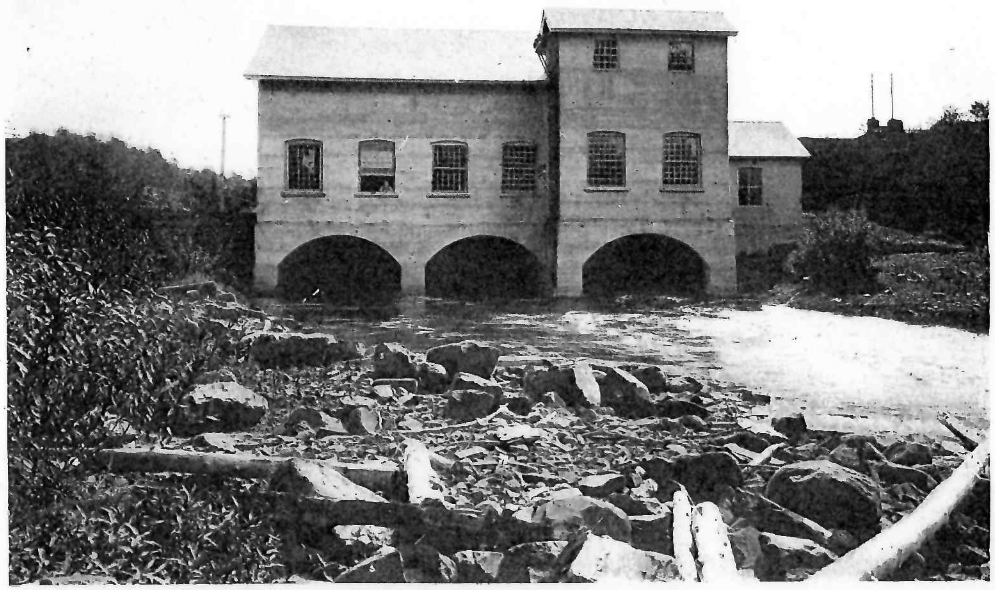
Since the original charter of the Mond Nickel Company did not provide for any developments of hydro-electric power, a subsidiary Power Company, known as The Lorne Power Company, Limited, was formed. This Company has erected a power-station at the Wabageshik Falls, about four miles from the village of Nairn, Ontario, on the Soo branch of the Canadian Pacific Railway. At this plant, which is on the Vermilion River, there are two pair of 38 in. diameter water-wheels, under 54 ft. head at high-water stages and 70 ft. head at low-water stages, developing 4,400 horsepower.

At the forebay the water passes through the intake racks and through two 10 ft. diameter screw-operated steel gates, to the two steel penstocks, which are 8 ft. in diameter and made of 5/16-in. steel. At the lower end these penstocks form part of the water-wheel casings. Directly connected to the two pair of water-wheels are the two 3-phase, 60-cycle, 2,200-volt, 1,500 K.V.A. Generators. Between the two water-wheels and generators are two 60 K.W. Exciters connected direct to two small water-wheels. The current at 2,200 volts from the Generators is stepped-up to 47,000 volts in the three 1,000 K.V.A. single phase transformers located in the Transformer Tower. This Power Plant is equipped with switchboards on which are mounted switches for Exciter control, main Generator control, outgoing line control, all with necessary instruments, and switches for lighting circuits. The lightning arresters are of the electrolytic type and are of ample size to protect the plant and line.

To meet the still further increased demands for Power, the Lorne Power Company has erected another Power Plant near Nairn, on the Spanish River. The head ranges from 27 to 31 feet, and about 4,800 h.p. can be developed. Two vertical high-speed water-wheels are capable of developing about 2,400 h.p. with 30 ft. head. These wheels approach 90 per cent. in efficiency. They drive two generators, 1,600 K.V.A. each, running at about 100 revolutions. The Plant also includes one vertical Exciter, 180 h.p. water-wheel driven, and a motor-generator set. The Nairn plant has been so constructed that a third unit can be added if required.

The plant has been connected up with the Wabageshik Power plant, so that in case of any accident to either plant, the mines can be kept in operation up to the limit of the power generated at any one of the Company's Power Plants.

Another water power, the "High Falls" on the Onaping River, close to the Levack mines, has been arranged for in order to provide power for any future need at the Company's Mines and Smelter at Coniston.



WABAGESHIK POWER PLANT.
EXTERIOR VIEW OF POWER HOUSE FROM DOWN STREAM.

POWER DISTRIBUTION

THE Power is distributed by copper wire carried on cedar poles spaced about 100 feet apart and on 25 steel towers spaced about 400 feet.

The pole line from the Wabageshik Power Plant and the one from Nairn Falls Plant form junction at Mond, Ont., and through the double-throw switches at this point, power can be delivered to any sub-station from either power plant.

The first power is taken off at Worthington Mine over eight miles of the pole line, and at this point 600 H.P. is used. The current is received at 47,000 volts and transformed to 550 volts, at which voltage it is used in motors.

The next sub-station is located at Mond, Ontario. At this point, twelve miles from the Power Plants, by pole line, another 600 H.P. is taken off and used in the same way as at Worthington.

From about a mile beyond the junction of the pole lines, from both Power Plants and over seventeen miles of pole line, another 1,000 H.P. is taken to Levack Mine and transformed to 550 volts in the sub-station, and so distributed about the mine plant.

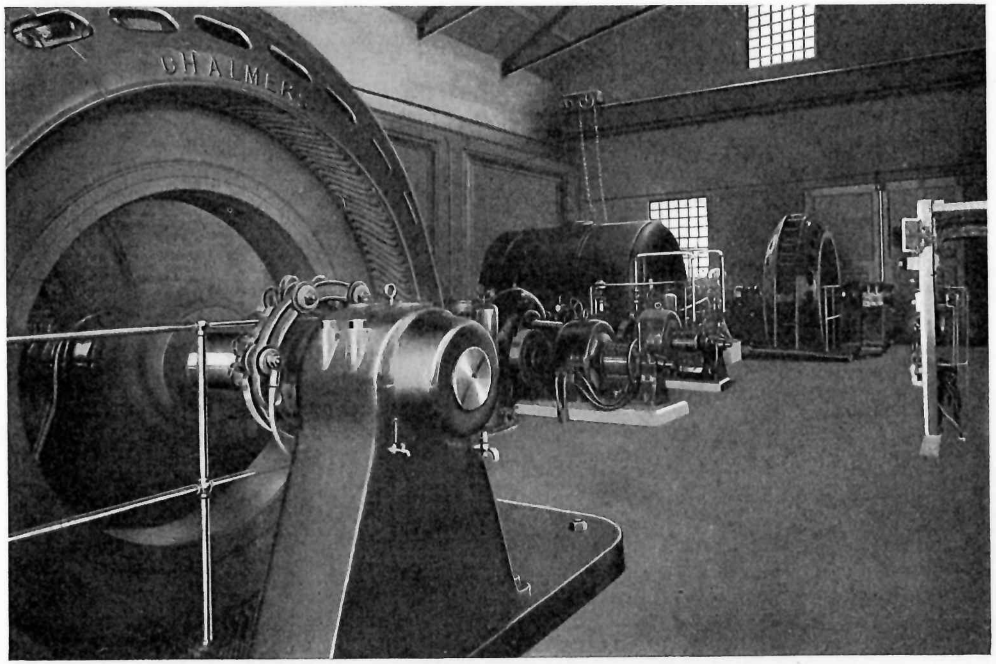
The Garson Mine sub-station, located 43 miles by pole line from the Power Plants of the Lorne Power Company, transforms about 1,620 H.P. to 550 volts for use at the mine plant. In addition to this, 600 H.P. can be supplied by the Wahnapitæ Power Company over about seven miles of pole line at 16,000 volts and transformed to 550 volts. All machines at Garson Mine are arranged with double-throw switches, so that any machine can be operated from either of the Lorne Power Company Plants, or alternatively from the plants of the Wahnapitæ Power Company, this station being connected with both distributing stations.

In addition to the power required at the mines for the equipment of Compressors and other machinery, power is required intermittently by the hoists at the different mines, and rarely the full hoisting capacity is used at any two mines at the same minute; the raising of the Company's dam at the Wabageshik Power Plant so increased the power available, that this plant is capable of operating alone the total mine equipment installed by the Company at the present time.

Part of the power required to operate the Coniston Smelter Sintering Plant and Test Plant is purchased under long-time contract from the Wahnapitæ Power Company. This power is generated at the Wahnapitæ Power Plant, located only one-and-a-half miles from Coniston, having the advantage of short pole line, or in case of accident, or of any unavoidable shutting-down of the Wahnapitæ plant, power can be furnished from the Burnt Chute Plant, which is located eighteen miles below the Wahnapitæ Plant.

The current from these plants is brought in at 16,000 volts to the transformer station at the Power House, transformed and delivered to the Wahnapitæ Power Bus Bars behind the switchboard at 550 volts.

The remaining power required at the Coniston Reduction Works is taken from the Lorne Power Company at 47,000 volts, transformed and delivered to the Lorne Power Bus Bars behind the switchboard at 550 volts, all machinery being connected to both sets of bus bars by double-throw switches.



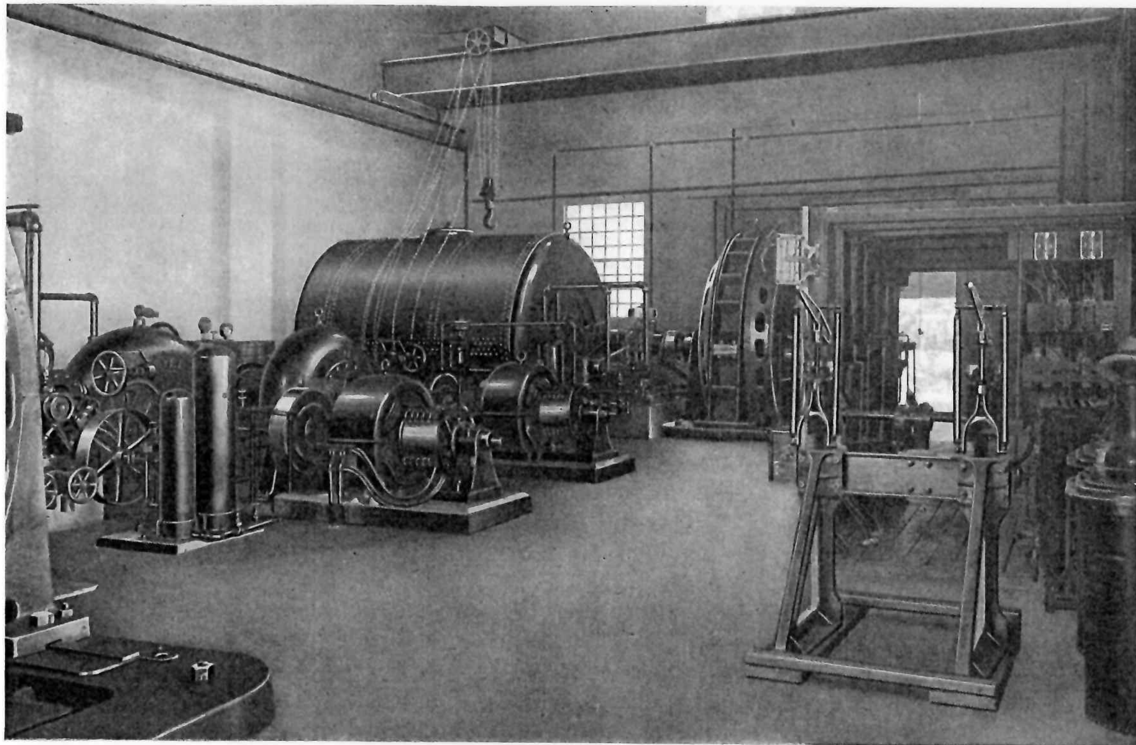
WABAGESHIK POWER PLANT.
INTERIOR VIEW OF POWER HOUSE.

WABAGESHIK POWER PLANT

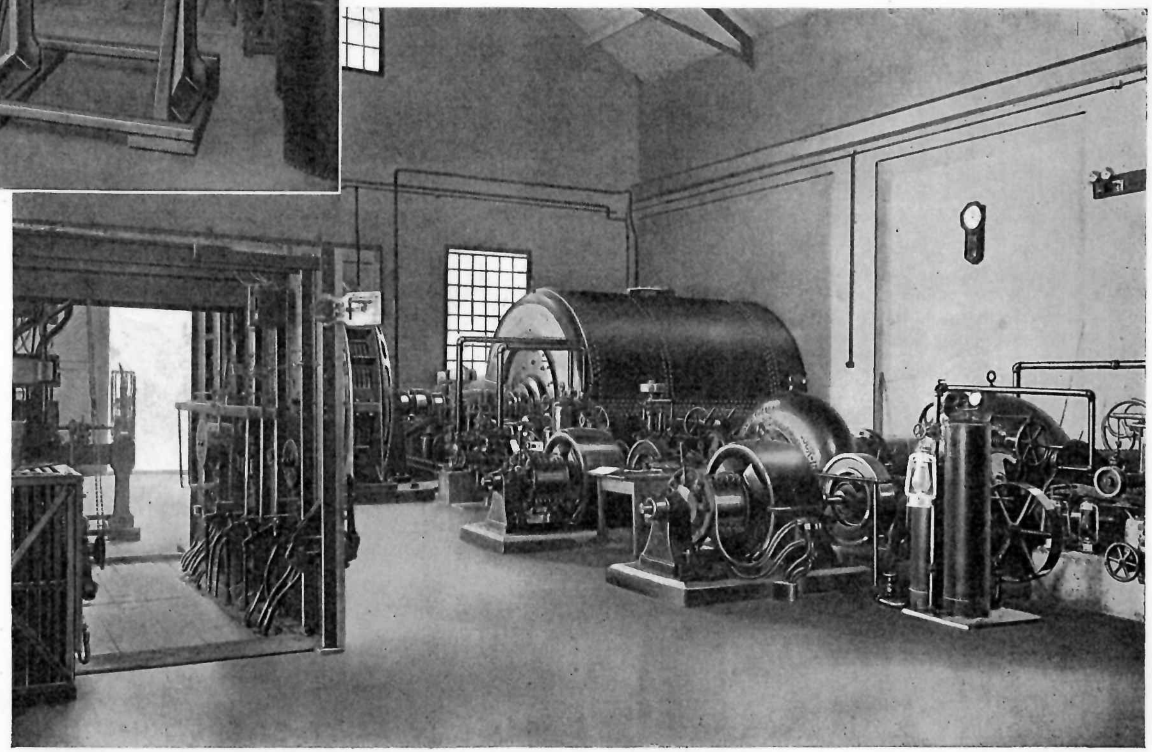
WABAGESHIK POWER PLANT.
MAIN DAM AND LOG CHUTE.

WABAGESHIK POWER PLANT.
VIEW OF FORBAY AND OPERATING MECHANISM OF INTAKE GATES.
LORNE POWER COMPANY, LIMITED.

WABAGESHIK POWER PLANT



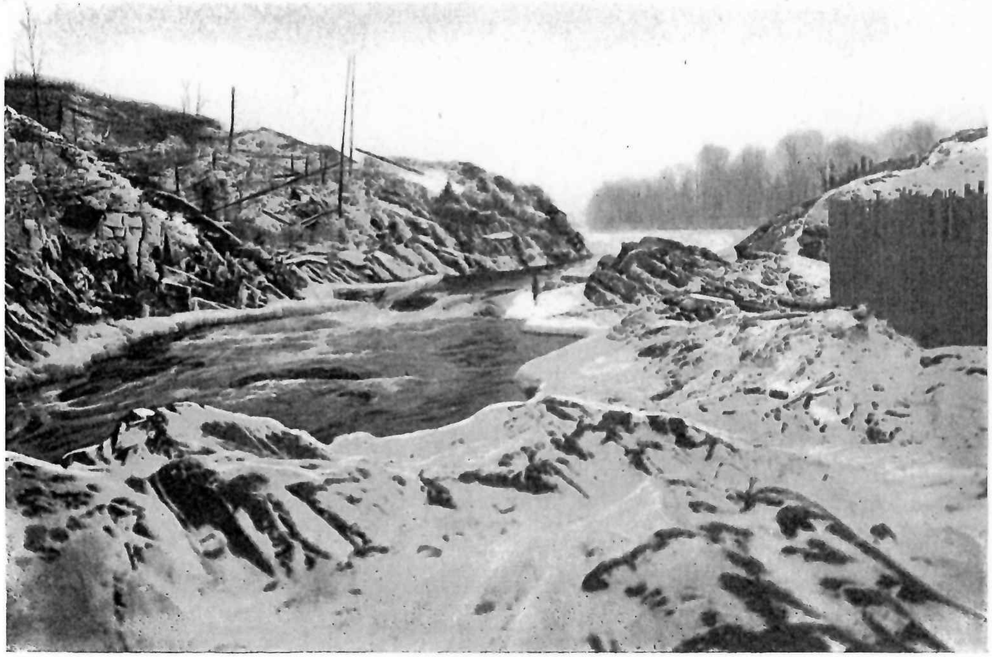
WABAGESHIK POWER PLANT.
INTERIOR VIEW SHOWING NO. 1 UNIT.



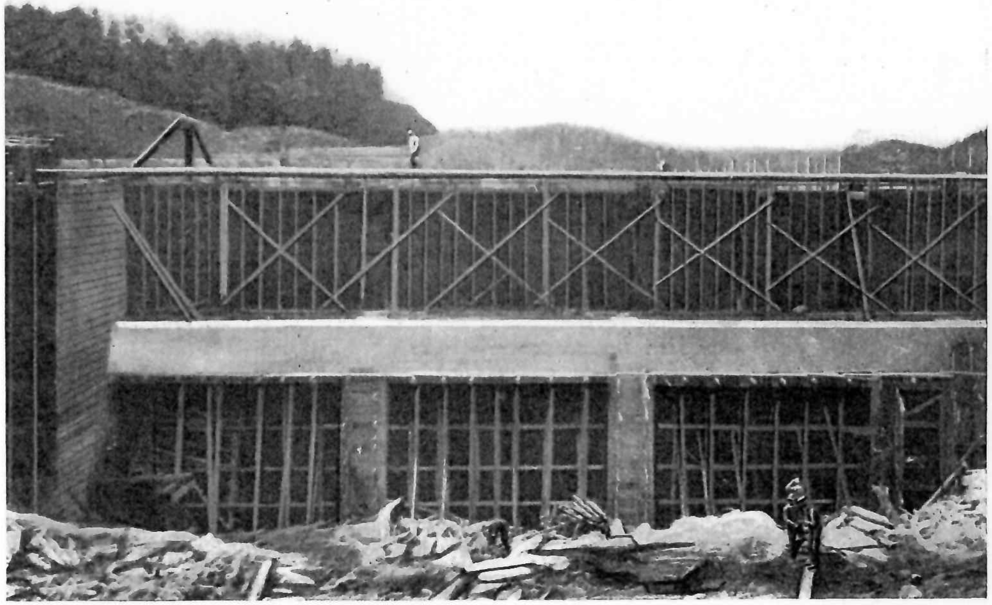
WABAGESHIK POWER PLANT.
INTERIOR VIEW SHOWING NO. 2 UNIT.

Nairn Falls Power Plant

NAIRN FALLS BEFORE HARNESSING.
Showing Middle Fall in Main Channel of Spanish River, where the New Hydro-Electric Power Plant has been Erected.
(Lorne Power Company, Limited).

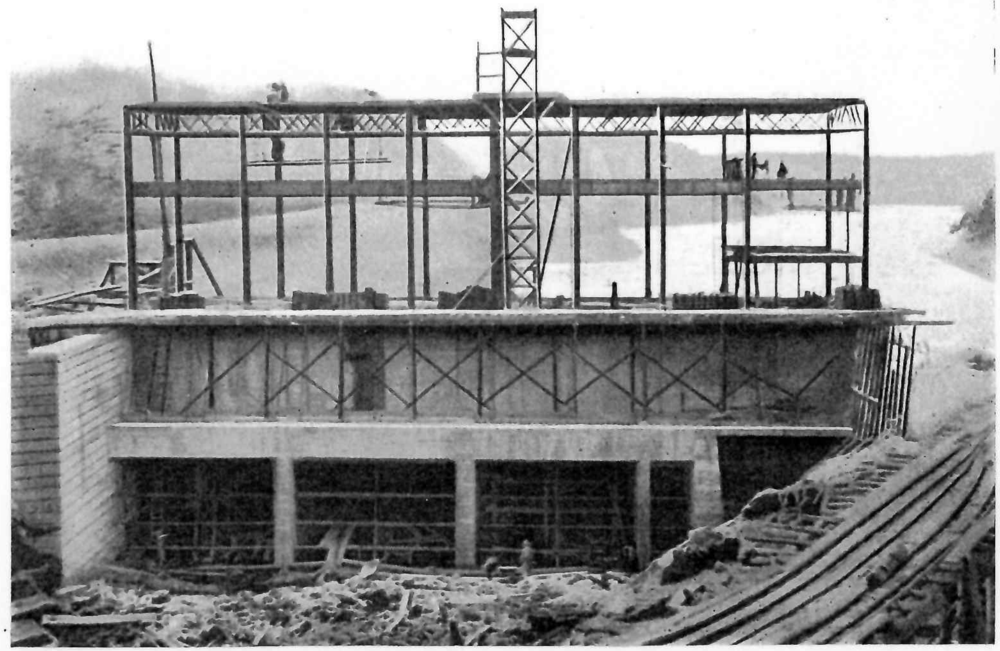


NAIRN FALLS PLANT.
SHOWING HEAD WATER ON MAIN CHANNEL OF SPANISH RIVER AT NAIRN FALLS.



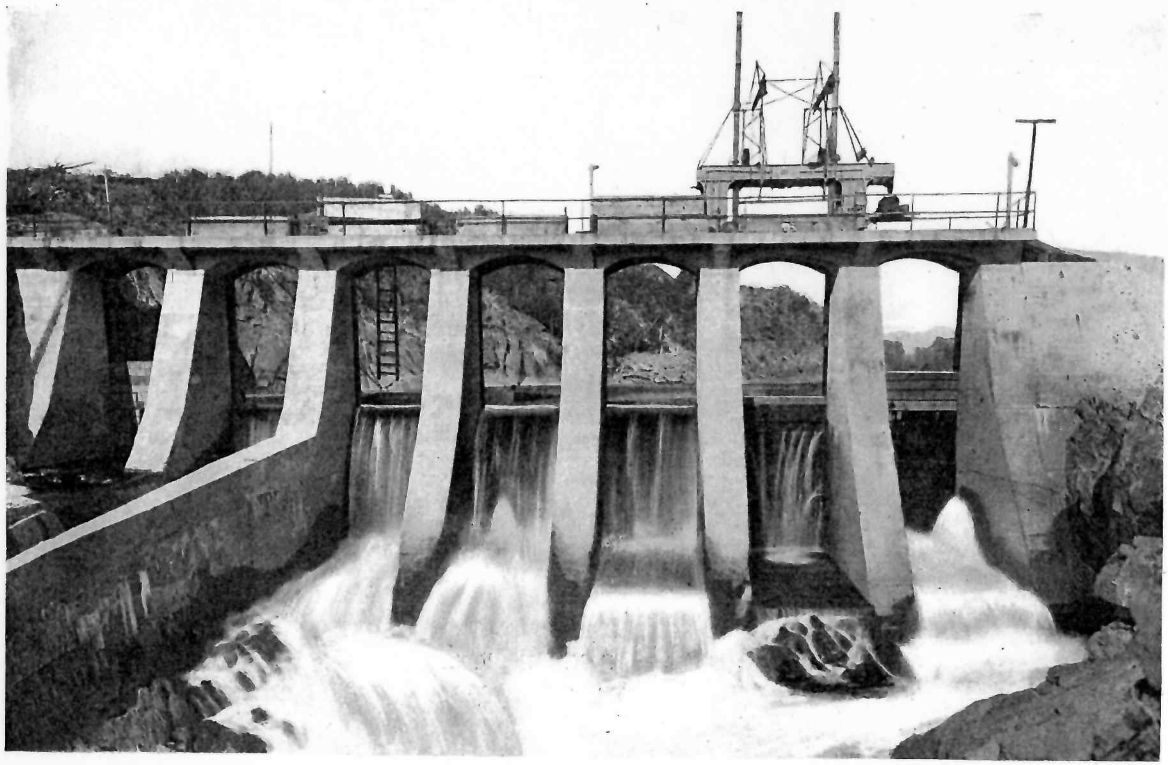
CONSTRUCTION OF NAIRN FALLS PLANT.—SEPTEMBER, 1915.
SHOWING THREE MAIN UNIT INTAKES AND EXCITER INTAKE, AND PART OF THE BASEMENT WALL OF POWER HOUSE INTAKES. ON LEFT IS WING WALL. FORM WORK STILL IN PLACE.

CONSTRUCTION OF NAIRN FALLS PLANT.—SPRING, 1915.
SHOWING FIRST COFFER DAM LOOKING UP-STREAM OF SPANISH RIVER.



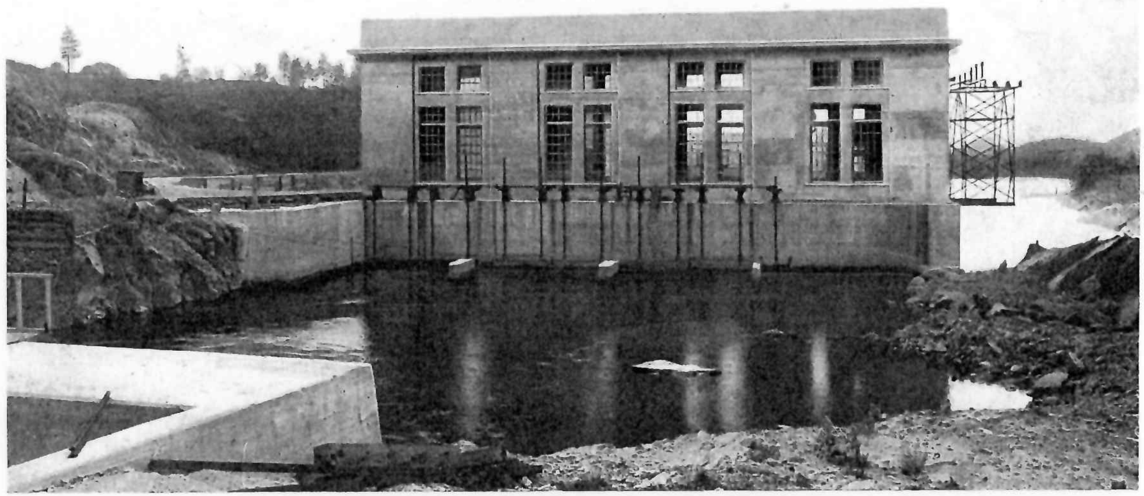
CONSTRUCTION OF NAIRN FALLS PLANT.—OCTOBER, 1915.
SHOWING INTAKE SIDE OF POWER HOUSE WITH FORM WORK PARTLY REMOVED, AND STRUCTURAL STEEL FRAME COMPLETED, READY TO COMMENCE TILE WALLS AND ROOF.

NAIRN FALLS POWER PLANT



NAIRN FALLS POWER PLANT.

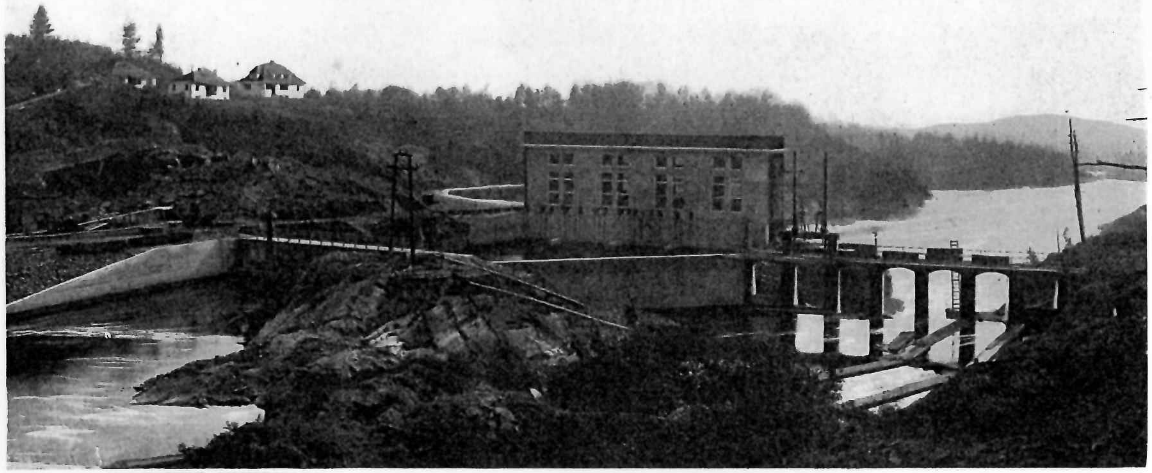
DOWN STREAM SIDE OF MAIN DAM, SHOWING LOG SLIDE AND STOP LOG WINCH.



NAIRN FALLS POWER PLANT.

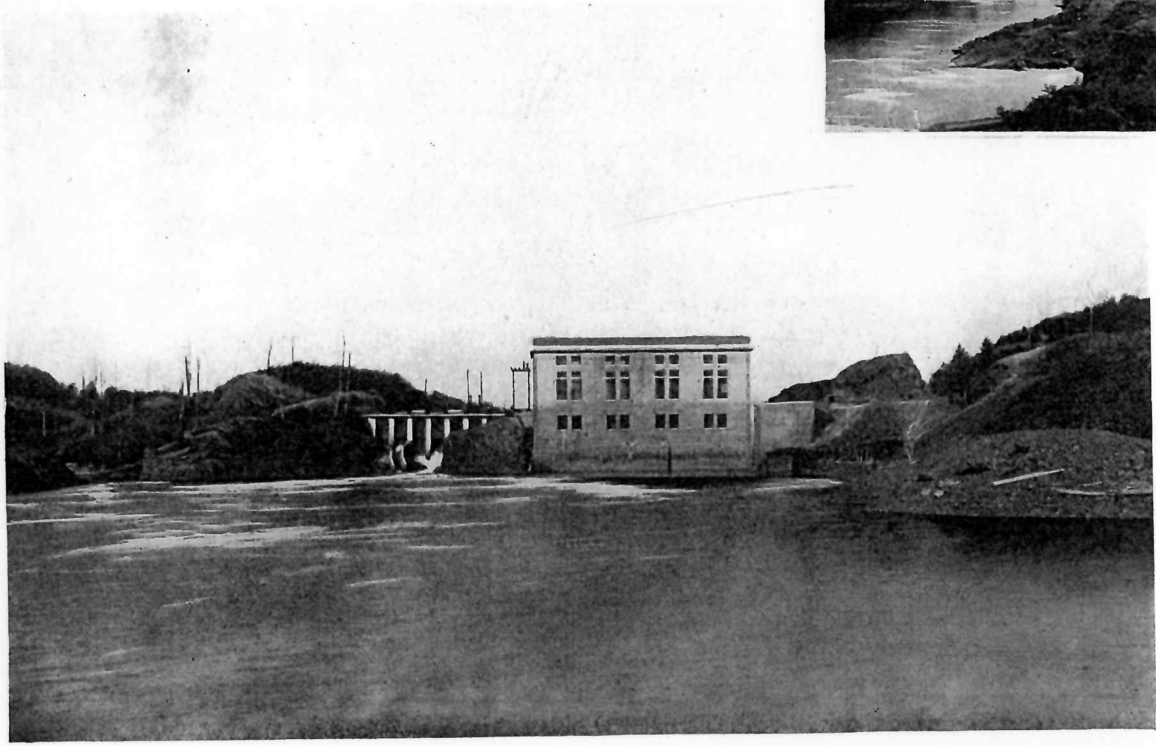
EXTERIOR VIEW, INTAKE SIDE, SHOWING GATE OPERATING MECHANISM AND FORBAY.

Nairn Falls Power Plant



NAIRN FALLS POWER PLANT.

General View from Up Stream, showing Power House, Main Dam and Intake Racks.



NAIRN FALLS POWER PLANT.

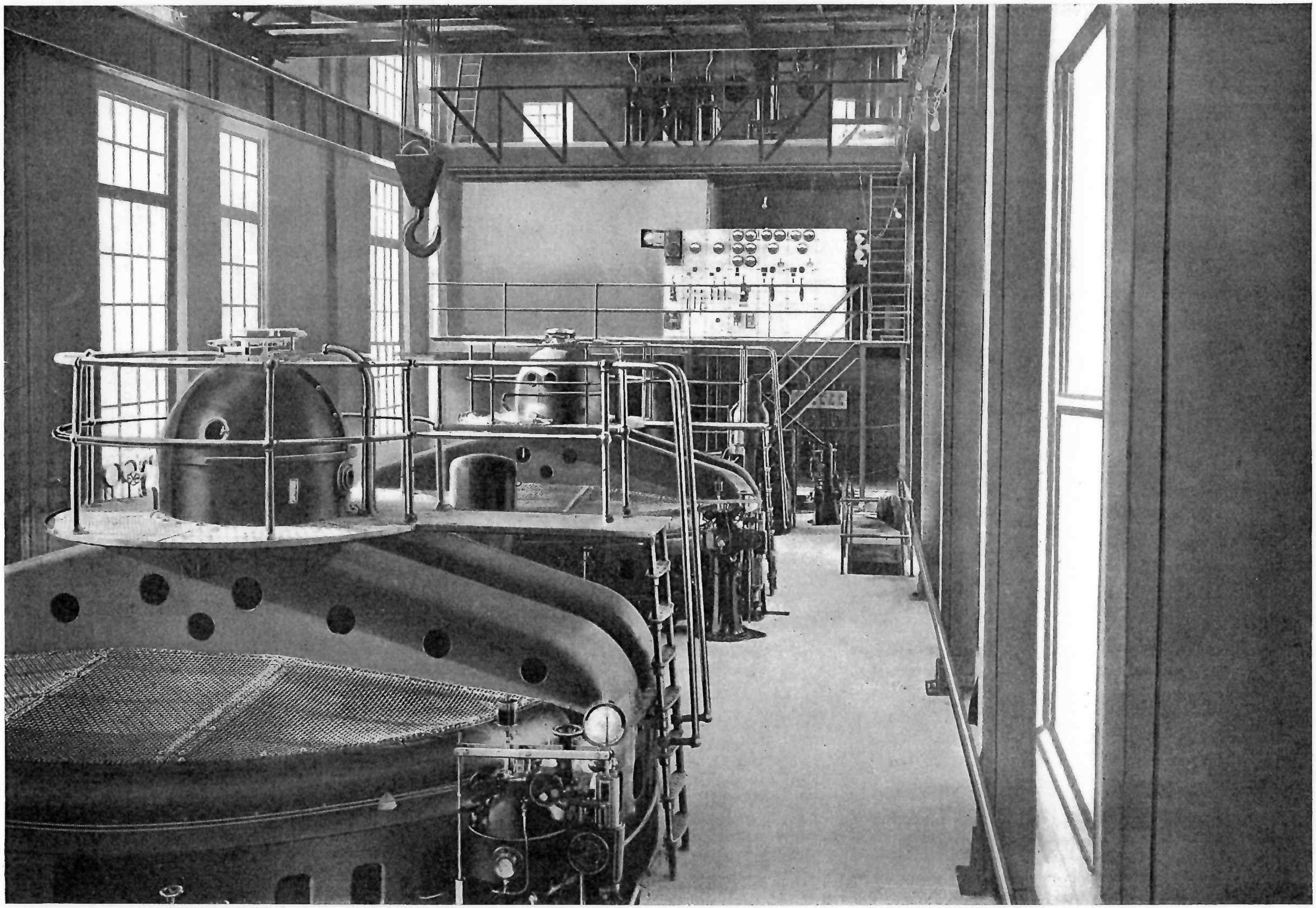
General View from Down Stream, showing Power House, Main Dam and Log Chute.

Nairn Falls Power Plant

NAIRN FALLS—AFTER HARNESSING.

Showing Hydro-Electric Power House after Completion of Plant.

NAIRN FALLS POWER PLANT



NAIRN FALLS PLANT.

INTERIOR VIEW OF POWER HOUSE, MAIN GENERATOR FLOOR LOOKING FROM UP STREAM SIDE TOWARD SWITCHBOARD END, SHOWING GOVERNORS AND HYDRAULIC EXCITER UNIT.

THE REFINING WORKS AT CLYDACH

The Process

THE Bessemer matte is shipped from the Company's Smelters at Coniston viâ the Canadian Pacific Railway or the Canadian Northern Railway to Montreal, and thence to Swansea, Wales, near which port the Company's Refining Works are situated. Here the matte, which consists of a mixture of about equal parts of Nickel Sulphide and Copper Sulphide, and a small percentage of Iron, is refined by the process known as the Mond Nickel, or Nickel Carbonyl, process.

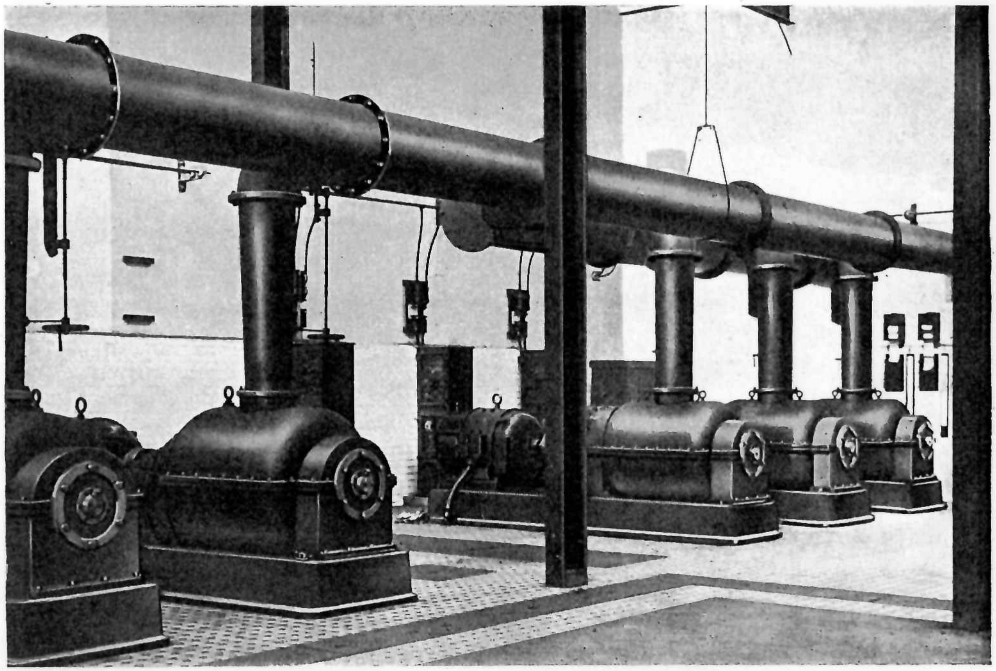
This process is based on the discovery made in 1889 by Mond, Langer & Quincke (C.T. 57, 749) that finely divided metallic Nickel combines at ordinary temperature with Carbon-monoxide to form a volatile compound, Nickel Carbonyl, which has the property of decomposing into its component parts at a temperature of 150° to 180° C.

To prepare the finely divided crude Nickel from the matte three operations are necessary :—

1. The matte has to be converted into a mixture of Nickel and Copper Oxide. This is done by submitting the finely-ground matte to an oxidizing calcination.
2. The bulk of the Copper present in the matte is removed by treating the oxides with dilute sulphuric acid at a temperature of 80° C.
3. The dried Copper extracted matte is reduced to the metallic state by means of water gas at a temperature of about 350° C.

The finely divided crude Nickel obtained is now ready for the treatment with Carbon-monoxide. This operation

4. is carried out in an apparatus called a Volatilizer. In this Volatilizer the metal powder is spread out over a large surface to enable the Carbon-monoxide to come into intimate contact with the Nickel. A continuous flow of Carbon-monoxide through the Volatilizer is kept up by means of a circulating blower. The Nickel Carbonyl is very volatile and is therefore carried out of the Volatilizer by the gas stream.
5. To recover the Nickel, the gas mixture from the Volatilizer is passed through an apparatus called a Decomposer. This apparatus is heated to a temperature (180° to 200° C.), at which the Nickel Carbonyl is decomposed into metallic Nickel and Carbon-monoxide. The Carbon-monoxide passes on to the Volatilizer and takes up a fresh lot of Nickel, etc. The Nickel is deposited on Nickel shot contained in the Decomposer. This shot is kept in continuous motion to prevent the newly-deposited Nickel from baking the whole mass together. When the shot has grown to a certain size it is removed from the Decomposer and replaced by a smaller size Nickel shot. As every speck of Nickel dust in the Decomposer is nickel-plated and gradually grows to the size of standard shot, no new Nickel shot need be introduced after the process has once been started.

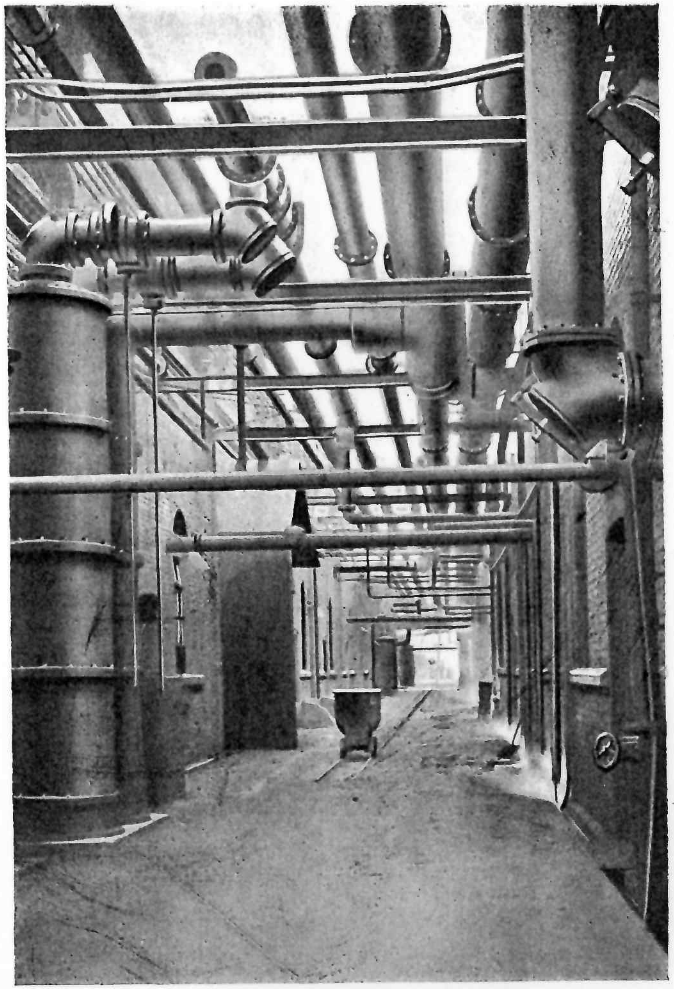


NICKEL REFINING WORKS.
No. 4 Engine House, showing Air Blower.

REFINING WORKS—*continued*

From the Volatilizer a certain amount of residue is discharged, consisting of unextracted Copper and Nickel and all the impurities contained in the original matte. This residue is re-melted to remove the impurities as much as possible and re-treated like the fresh matte.

The Nickel produced by this process is of the highest purity (99·8 to 99·9 per cent. N.) and free from Cobalt, as the latter does not form a volatile Carbonyl under the conditions in which the process is carried out.



NICKEL REFINING WORKS.
PIPE RANGE IN ROADWAY.

Large quantities of coal are required for this process, and full advantage is taken of the situation of the Refining Works, which are in the midst of the Welsh Anthracite and Steam Coalfields. It is therefore possible for the Works to be supplied, at a very low cost, with the coal which the process requires for power, steam, and gas.

The products made in the process are :—

1. Sulphate of Copper.
2. Nickel.
3. Nickel Salts.

COPPER SULPHATE

Copper Sulphate (also known as Blue Vitriol, or Blue Stone), of 99/100% purity, is manufactured by the Company in very large quantities.

It is used in agricultural, dyeing, and other industries, the principal consumption being for agricultural purposes in the vine-growing countries, as a prevention against diseases of the vine, such as mildew, phylloxera, etc.

It is also used for spraying potatoes, peas, beans, etc., and fruit trees, as a preventative against the common diseases to which these plants and trees are subject. It is also in great demand for wheat dressing, and takes an important place among weed-killers; and again, it is well known as a sheep dip.

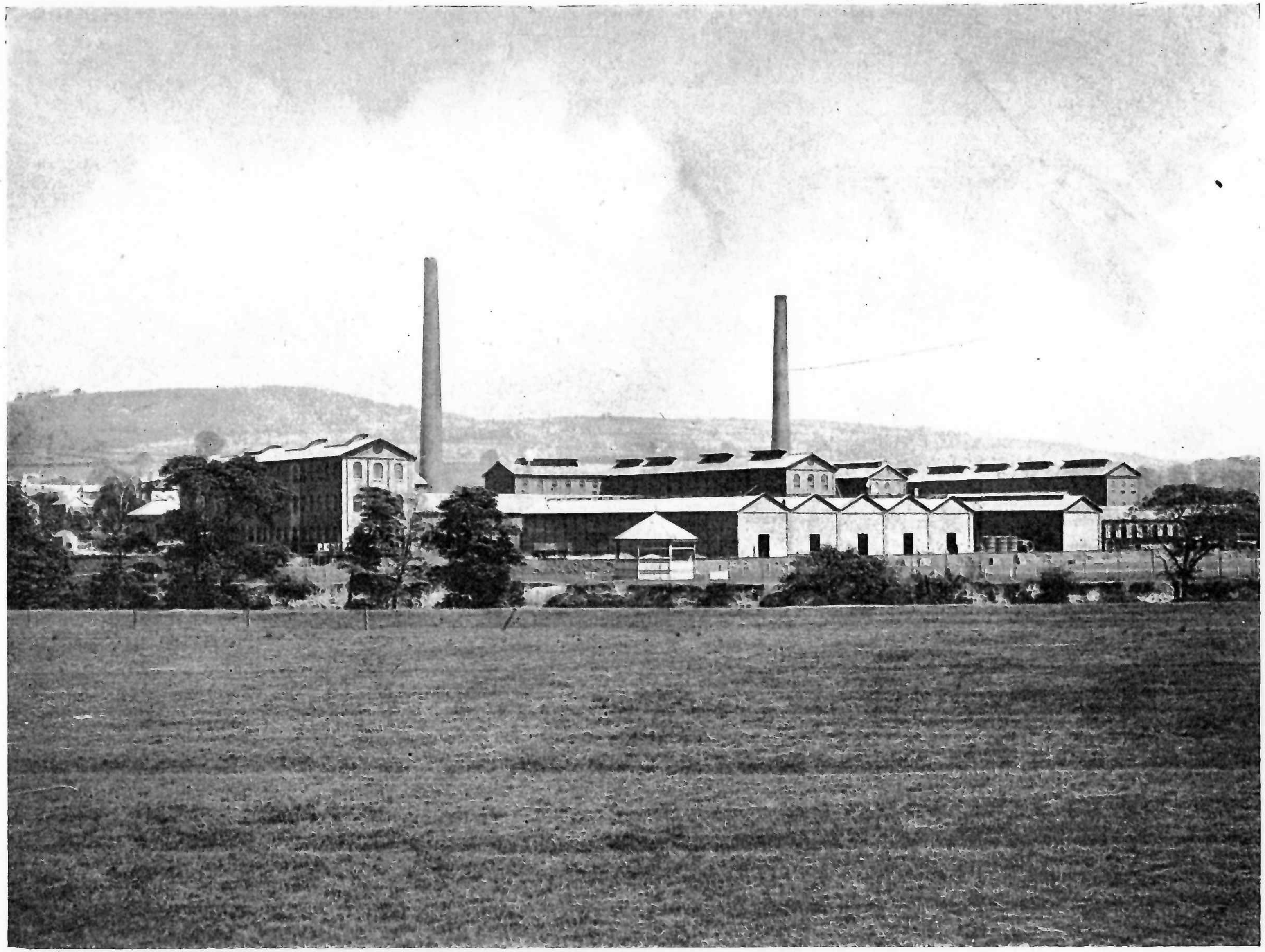
It is recognised that spraying with Sulphate of Copper is the only preventative against these diseases, and great efforts have been made by the agricultural departments to impress upon growers the advantages of spraying, and in some countries the spraying of plants has been made compulsory.

Copper Sulphate is largely exported from Swansea to Italy, France, Algiers, Spain, Portugal, Roumania, Switzerland, Russia, and other vine-growing countries.

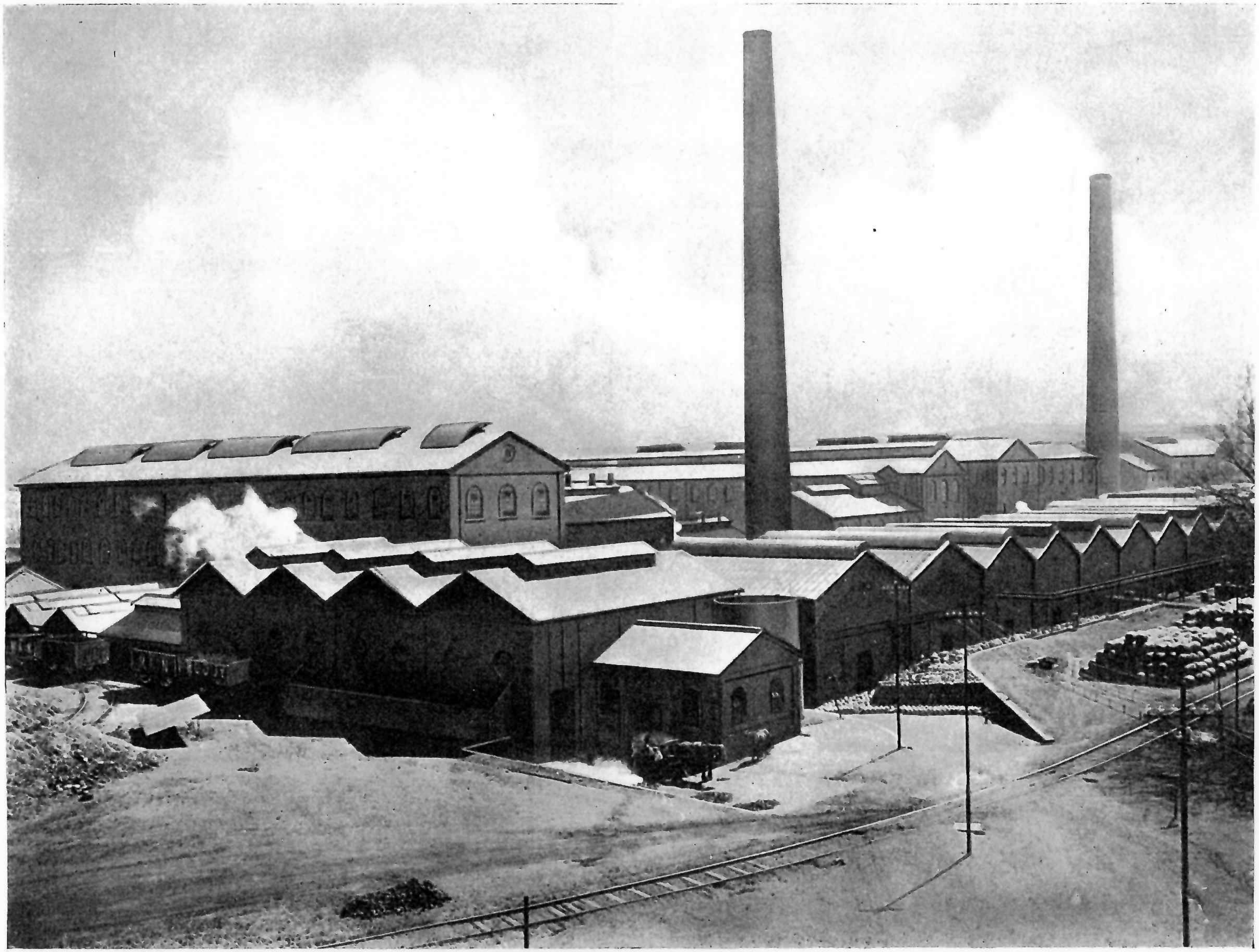
NICKEL SALTS

Nickel Sulphate and Nickel Ammonium Sulphate, of high purity, are manufactured by the Company. These products are largely used in the nickel plating industry, both at home and abroad.

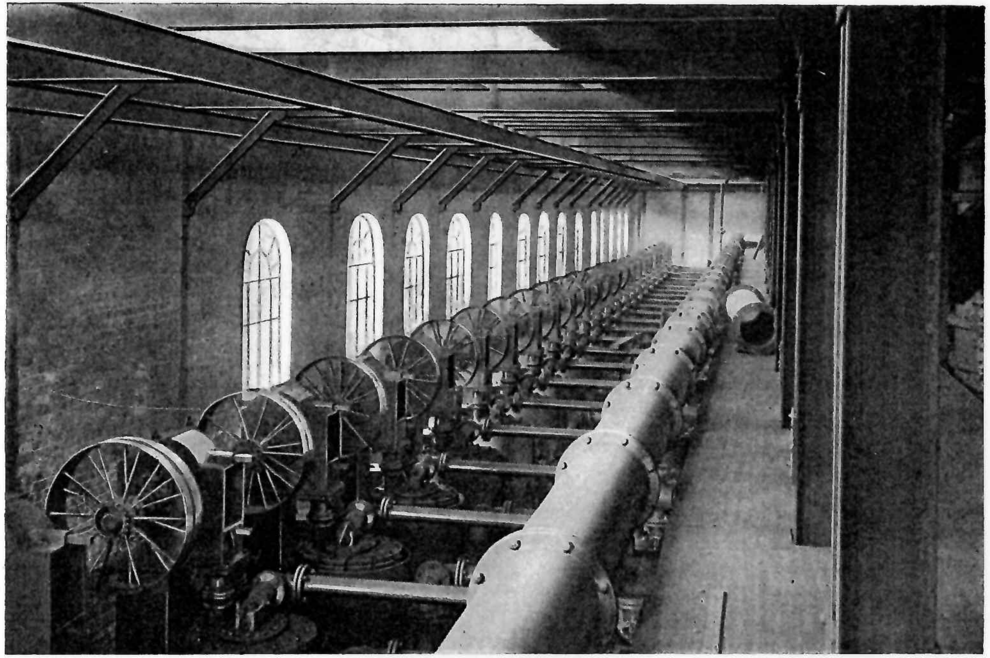
Nickel Sulphate is also used for catalysing purposes, which industry has been developed on a large scale during the last four years, and by the introduction of this process many fats and oils, previously unusable, have been made available for the soap, margarine, and various other industries.



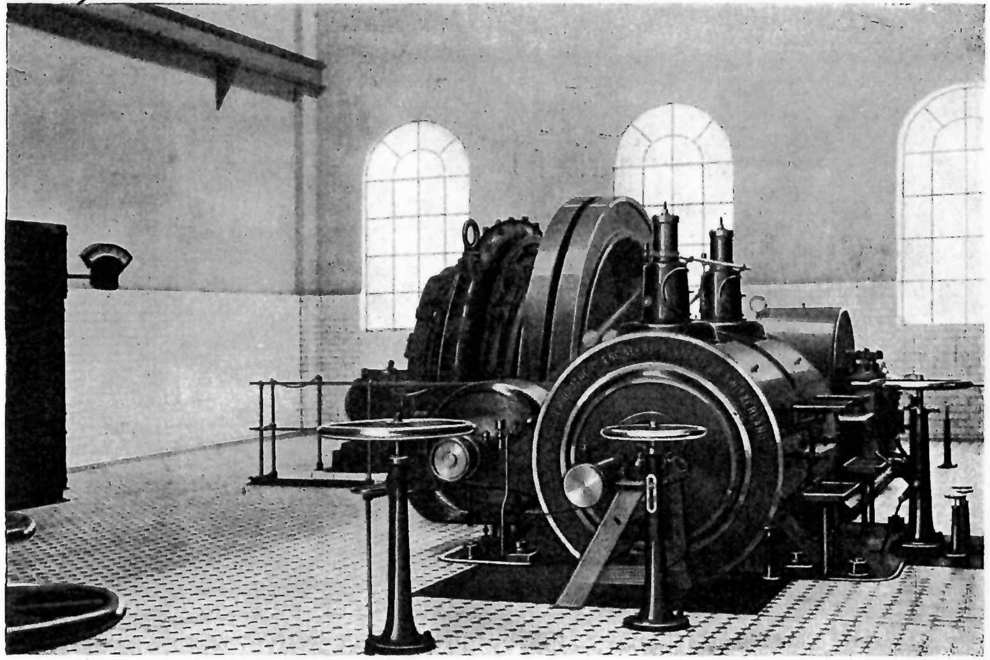
THE MOND NICKEL COMPANY'S REFINING WORKS, CLYDACH, NEAR SWANSEA.



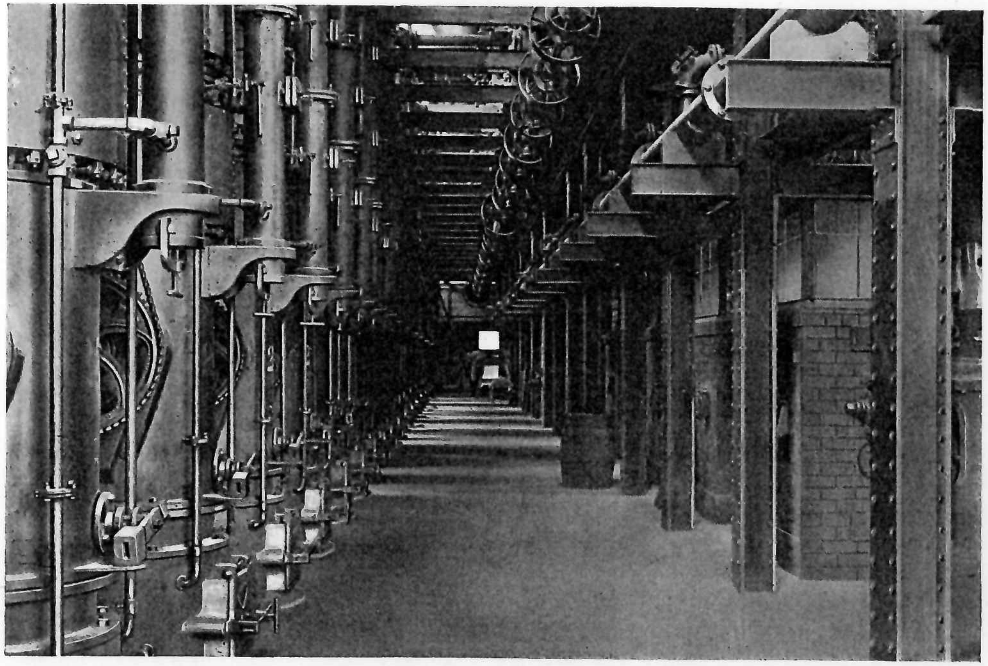
THE MOND NICKEL COMPANY'S REFINING WORKS, CLYDACH, NEAR SWANSEA.



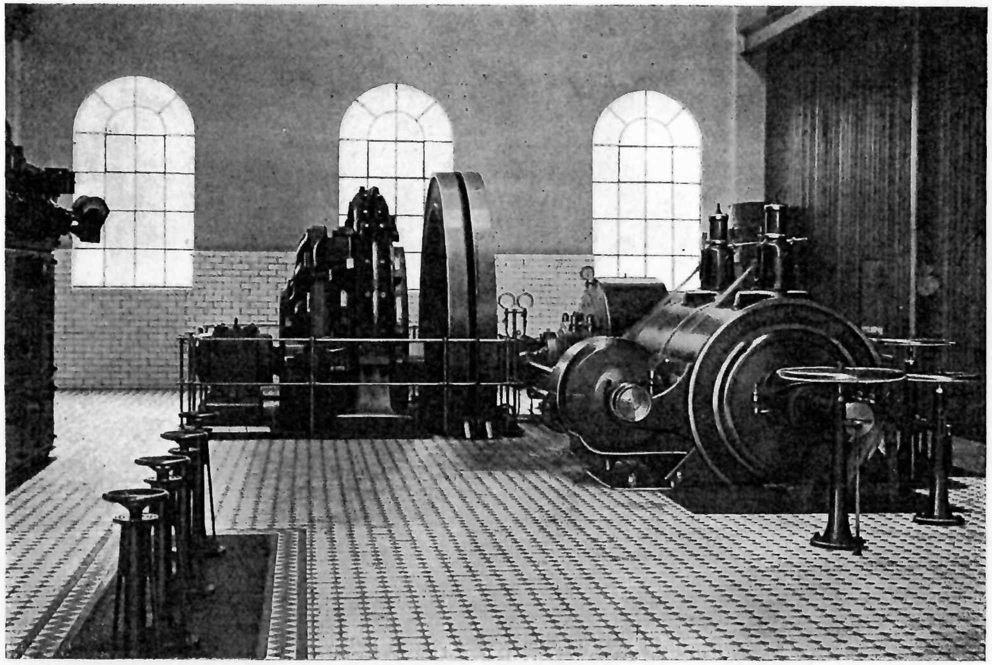
NICKEL REFINING.
INTERIOR OF WORKS, SHOWING TOP OF DECOMPOSERS.



POWER PLANT.
VIEW IN NO. 5 ENGINE HOUSE, SHOWING 800 K.W. GENERATOR.



NICKEL REFINING.
INTERIOR OF WORKS, GROUND FLOOR, SHOWING DECOMPOSERS.



POWER PLANT.
ANOTHER VIEW IN NO. 5 ENGINE HOUSE, SHOWING 800 K.W. GENERATOR.

THE USES OF NICKEL

A General Survey

THE uses of Nickel are so many and so diverse, and are extending so rapidly, as to be almost innumerable. Whilst the importance of pure Nickel is continually increasing, its chief utility lies in the production of alloys, and particularly of Nickel Steel, in which at the present time, the greater part of the Nickel refined is employed.

The alloy of Nickel and Iron is no novelty, since practically all native Iron, of terrestrial and meteoric origin, contains Nickel. Moreover, as far back as 1822, experiments were made by Faraday in alloying Nickel and Iron, since which time improvements in the process have been made continually.

By reason of the war, Nickel has been brought very prominently before the notice of the public, for without Nickel no modern war can be carried on, and no modern battleship built. Indeed, that for certain purposes Nickel is essential, no more conclusive evidence can well be required than that afforded by the proportionately large amount of tonnage reserved for Nickel in the cargoes of the submarines "Deutschland" and "Bremen," when undertaking their perilous voyages between Germany and the United States in the latter part of 1916.

Nickel being indispensable in numerous branches of modern steel manufacture, the importance of the metal is self-evident. Steel to which a small proportion of Nickel has been added is considerably altered in character, this improvement of its qualities rendering it particularly well adapted for constructional work of many kinds. For this reason, Nickel Steel is now very extensively employed in bridge building, in the manufacture of naval and military armaments, and for motor building, and many similar industries.

The remarkable properties of Nickel—which approaches the precious metals in its powers of chemical resistance while far exceeding them in hardness and toughness—have of late years led to its employment in the manufacture of high-class cooking utensils and kitchen-ware, and in an ever-increasing degree for cookers, dishes, forks and spoons, coffee-pots, teapots, table-jugs, basins, baths, crucibles, stills, and hollow-ware of every description used throughout the technical arts.

Being not only sanitary and easy to clean, but taking a high polish, difficult to discern from that of silver, and retaining this with the expenditure of very little labour, Nickel is an ideal metal for cooking utensils, as anyone will discover on walking through the kitchens of a great American railway express. Naturally, therefore, Nickel is in increasing demand in the hotel world, as evidenced by such beautiful and glittering kitchens as, for instance, those of the Curzon Hotel, or the famous White Star Liner, "Olympic."

It is of interest to add that military field kitchens employing Nickel utensils are so perfectly designed that food for 260 men can, it is stated, be prepared in the course of a few hours, even when on the march.

Owing to the fact that Nickel is malleable, ductile and hard, and that it takes a high polish, and possesses great powers of resistance to atmospheric oxidation, it is in great request for the electro-plating of small articles made of iron, steel and other metals, to prevent them from rusting, and in the manufacture of rifle bullets, upon which a layer of Nickel is deposited which confers upon them a hard, clean surface that will not foul the barrel. For the same reason, a considerable amount of Nickel, in the form of Nickel-Silver and Electro-plate, is used in the manufacture of table-ware, ornamental articles, wire, medals, and coins.

Nickel, in a very finely-divided state, and in the form of Nickel Salts, is employed in the hardening of oils and fats. By the action of hydrogen in the presence of finely-divided Nickel, liquid oils, such as fish oil, linseed oil, olive oil, etc., can be "hardened" into solid fats suitable as basis materials in the manufacture of candles, soap and certain foodstuffs.

For these purposes it is essential that the Nickel be very pure.

Nickel is largely imported into European countries in the forms of Nickel ore, Nickel matte and Nickel oxide. It is also imported and exported in such forms as sheets, plates, strips, cubes, bars, rods, wires, tubes, pipes, ingots, pellets, etc.

Canada is the country where a large percentage of Nickel ore is found, and an extremely important industry has been built up in the Sudbury district of Ontario, where the Nickel-Copper mines are situated. That British capital and enterprise have taken a large share in developing this industry will be apparent from the particulars embodied in this volume.

Growth of the Sudbury Nickel Industry

The rapid growth of the Nickel Industry in Canada is an indication of the increasing demand for this metal. The following table gives the production of Nickel in Canada since 1902:—

PRODUCTION OF NICKEL.

YEAR.	TONS.	YEAR.	TONS.
1902	5,945	1910	18,636
1903	6,998	1911	17,049
1904	4,729	1912	22,421
1905	9,503	1913	24,838
1906	10,776	1914	22,759
1907	10,602	1915	34,039
1908	9,563	1916	41,299
1909	13,141		

The above table shows that there has been a steady increase in the production of Nickel during the last fifteen years. The years 1906—1910 show an increase of 78·6 per cent. over the preceding four years; 1911—1915 shows an increase over 1906—1910 of 101·9 per cent., and the increase of 1916 over 1915 was 18 per cent. This rapid development is clearly the result of an increasing demand, a fact which is further illustrated by consideration of some of the many uses to which Nickel is put. A survey of these is contained in the following pages.

Nickel Metal

THE demand for Nickel is so great, and is so continuously increasing that it is not too much to say that the consumption of Nickel is more directly dependent upon the available supply than that of any of the other useful metals.

The opening of the now famous Nickel mines of the Sudbury region of Ontario, where the first important Nickel mining operations took place in 1886, brought about a radical and welcome change in the Nickel industry. The Nickel matte from the Sudbury region can normally be delivered in New York within four days, and in European markets within a fortnight, as compared with about two months consumed in transporting the earlier-known South Pacific ores from the French mines on the New Caledonia Islands. The natural corrollary of this fact was that former prices have been very greatly lowered.

Nickel has physical properties similar to those of Iron and Copper. It allies with both these metals in practically all proportions. It is harder than either of them, is magnetic, has a greyish-white colour, takes a fine polish, and may be rolled easily into thin sheets or plates, or drawn into wire. It has, moreover, the useful properties of being unappreciably affected by either atmospheric action or salt water. Nickel is not difficult to cast, and bars of cast Nickel are compact and tough after hammering or rolling.

Nickel Steel

FOR a considerable time past, scientific research has been energetically and consistently directed upon the art of uniting elements in such proportions that they may be more serviceable than in their pure state. As a natural consequence, of the making and experimenting with alloys there has been no end, and amongst them it has been established that Nickel will alloy with most of the useful metals, and that the addition of Nickel generally confers upon the union the qualities of hardness, toughness and ductility. It will, however, be generally conceded that of all the numerous alloys with which scientific research has been concerned during recent years, the one which shows the greatest range of adaptation, and has met with the largest measure of approval, is *Nickel Steel.*

Nickel Steel was first introduced to public notice by Mr. James Riley, of the Steel Works of Scotland, in his paper, "Alloys of Nickel and Steel," read before the Iron and Steel Institute in 1889. Its field of usefulness has been rapidly enlarged, until, at the present day, the use of Nickel Steel is thoroughly recognised, and is of world-wide extent.

Nickel Steel containing from 2½% to 3½% of Nickel has certain of its properties greatly improved, so that for many purposes it is replacing ordinary structural Steel. The chief characteristic which distinguishes Nickel Steel as compared with simple Steel is its high elastic strength.

On low Carbon Steels not annealed, the addition of each 1 per cent. of Nickel up to 5% causes approximately an increase of 5,000 lbs. in the elastic limit and 4,000 lbs. in the ultimate strength. The influence of Nickel on the elastic limit and ultimate strength increases with the percentage of Carbon present, high Carbon Steels showing a greater gain than low Carbon Steels. The addition of Nickel to Steel raises the proportion of elastic limit to ultimate strength and adds to the ductility of the Steel. This effect of Nickel upon the elastic limit accounts for the increased working capacity of Nickel Steel over Carbon Steel and its increased resistance to molecular fatigue.

The following table, which shows a comparison of Carbon and Nickel structural Steels, gives some idea as to its superiority :—

	Medium Carbon Steel	Medium Nickel Steel
Percentage of Carbon	0·20	0·38
Percentage of Nickel	0	3·50
Elastic limit (lbs. per sq. in.)..	30,000 (Min.)	60,000 (Min.)
Ultimate tensile strength (lbs. per sq. in.)	60,000 (Min.)	105,000 (Min.)
Modulus of elasticity	29,000,000	30,000,000
Safe working stress in tension (lbs. per sq. in.)	16,000	28,000

It may be explained that the "Modulus of Elasticity," or "Co-efficient of Elasticity," as it is sometimes called, is the constant, indicating the relation between the amount of physical effect and that of the force producing it. The term, therefore, expresses the relation between the amount of extension, or compression, of a material, and the load required to produce that extension or compression.

This may be referred to, in passing, owing to a little prejudice still existing in the minds of some engineers against Nickel Steel, on the supposed grounds that the modulus of elasticity is lower for Nickel Steel than for Carbon Steel.

As a matter of fact, however, while the high Nickel Steels, especially those containing 20% and over, have a lower modulus of elasticity than Carbon Steels, Nickel Steels, such as would be used for structural purposes, and containing about 4 per cent. of Nickel or less, *have the same modulus of elasticity as Carbon Steels,* namely, approximately 29,500,000 lbs. per sq. in.

Perhaps the most important use to which Nickel Steel is put is for the manufacture of armour and heavy ordnance, where its great strength and toughness has proved of special value. It has been used for engines and propeller shafts for a number of years and has proved so much superior to other steels that it is now considered unrivalled for such purposes. On account of the increase in strength or decrease in weight, it has been used for crank pins, light forged engine frames, bolts for extreme hydraulic pressure, hydraulic forged cylinders, and railway axles; and from its peculiar resistance to fatigue under vibration, it is employed very successfully for piston rods in steam engines and drills.

The value of Nickel Steel for armour plates, when cemented and face hardened consists not only in its greater resistance to penetration, but in its non-fissibility. So completely is this recognised, that since the Washington Navy Yard first began experimenting with Nickel Steel, in 1876, every country in the world has come to rely on Nickel Steel for the armour-plating of its first-class ships of war.

THE MANHATTAN BRIDGE, NEW YORK CITY.

THIS GRACEFUL STRUCTURE, WHICH SPANS THE EAST RIVER, IS ONE OF THE MODERN BRIDGES IN THE CONSTRUCTION OF WHICH NICKEL STEEL HAS BEEN ADVANTAGEOUSLY EMPLOYED.

In this connection it may be mentioned here that Nickel prepared by the Mond Nickel Company is largely used in the manufacture of armour-plates for the British Government.

The great value of Nickel Steel as employed for the purposes of shipbuilding and armour-plating has been recognised with ever-increasing clearness during the past two decades. It is, therefore, of interest to state the views of a well-known authority, expressed twenty years ago, based upon the result of practical experiments and personal experience.

In the course of a scientific paper, "Nickel Steel as an Improved Material for Boiler Shell Plates, Forgings, and Other Purposes," read at the Thirty-eighth Session of the Institution of Naval Architects, on April 9th, 1897, the author, Sir William Beardmore, Chairman of Messrs. William Beardmore & Company, Limited, the well-known Engineers and Ordnance Manufacturers, gave expression to his opinion as follows:—

"In the history of iron and steel there have been many alloys which, on their first introduction, gave promise of great usefulness; but a more extended acquaintance led to disappointment. Quite the reverse, however, has it been with that alloy to which I now desire to direct your attention.

Nickel Steel has, by this time, won its spurs, and proved itself worthy of the confidence placed in it by those to whom its remarkable qualities are best known. . . . . .

The *sine qua non* of a structural material is that it be *reliable*.

We require a metal which can be worked without any special care on the part of the artisan; a metal which in shipbuilding will enable us to reduce the scantlings, take from the weight of the boilers, add to the strength and reliableness of the propeller shafts; a metal which will give the same results to-day and to-morrow, in China or Peru.

Nickel Steel . . . . fulfils these conditions, and is, in my opinion, a most suitable material with which to meet the demands for a metal stronger than steel. . . . . .

If we admit that the strength of steel is its elastic limit, it will not be difficult to make out a very good case for Nickel Steel, as it is here that this alloy shows its most striking characteristic.

In Nickel Steel of ·26 per cent. carbon, we have a *metal whose elastic limit is equal to the ultimate strength of ordinary Carbon Steel*. Mild Nickel Steel gives all the properties of high Carbon Steel without the treacherous brittleness so painfully evident in the latter. . . . . .

As a material for tyres and axles, Nickel Steel has many claims on our attention. Indeed, I am of opinion that there is a wide field for its use in this direction. . . . . .

A very striking feature of Nickel Steel is that, a crack appearing in it will not develop, as in Carbon Steel. . . . . .

As you will see from specimens broken under the hammer, the appearance of the fractures is very different. In the case of the Carbon Steel it is crystalline, but in the Nickel it is *fibrous*, and shows clearly the feature I wish to emphasize, namely, that Nickel Steel tears gradually, while Carbon Steel, once cracked, breaks short. Speaking a few years ago on the metal of the future, Mr. Edison, the great electrician, said, 'Nickel Steel is the coming thing; steel will crack, Nickel Steel you cannot crack.'

It seems to me, after numerous trials with the same results, that we have here a fact of immense importance, and one which marine engineers would do well to bear in mind. . . . . .

There are many other points connected with Nickel Steel on which I should liked to have touched. . . . . but enough, perhaps, has been said to show that Nickel Steel fulfils in a most satisfactory manner the conditions required of a material for shipbuilding and engineering purposes in an age not characterised by the modesty of its demands."

We may supplement the foregoing remarks by the following interesting table, from which it will be seen that the Yield Point of Nickel Steel of D226 grade is about equal to the ultimate tensile of ordinary Steel:—

COMPARISON OF YIELD POINTS AND BREAKING STRAIN OF NICKEL AND CARBON STEELS.

THICKNESS.	CARBON STEEL.		NICKEL STEEL.	
	ULTIMATE	YIELD POINT.	ULTIMATE	YIELD POINT.
	Tons per sq. inch.	Tons per sq. inch.	Tons per sq. inch.	Tons per sq. inch.
3/16"	27·5	13·7	51·7	29·0
,,	27·4	13·7	54·3	28·0
1/4"	27·8	13·9	54·3	28·3
,,	27·6	13·8	53·1	29·4
3/8"	27·9	14·0	52·6	30·6
,,	28·0	14·3	51·6	30·8
1/2"	28·5	14·3	52·1	28·6
,,	28·4	14·2	49·8	28·6
3/4"	28·5	14·1	50·8	28·7
,,	28·4	14·0	53·1	28·9
1"	27·9	14·3	48·9	29·2

In view of the many important advantages of Nickel Steel, succinctly outlined, it is natural to find an increasing demand for this material in the building of bridges.

Nickel Steel has been employed in the rebuilding of the Quebec Bridge, which collapsed so disastrously a few years ago. The same material has also entered largely into the construction of the Manhattan Bridge, New York.

A novel feature of the Manhattan Bridge is the use of Nickel Steel in the upper and lower truss cords, which are subjected to a working stress of 40,000 lbs. per sq. in., and notwithstanding the higher cost of the Nickel Steel, the saving is such as to make the trusses actually cheaper than if they were built entirely of ordinary structural Steel.

The weight of Steel in the superstructure from anchorage to anchorage, exclusive of the cables, is 10,500 tons of Carbon Steel and 8,000 tons of Nickel Steel. The weight of the cables is 6,300 tons, and the total weight of Steel in the whole bridge, including anchor chains, cables, towers and suspended span is 42,000 tons.

The suspension bridge proper, disregarding the approaches, consists of a main span 1,470 ft. long, and two side spans, each 725 ft. in length. The total width of the floor of the bridge is 120 ft.

Although the span is 140 ft. less than the span of the big cantilevers of the Forth Bridge, the enormous load which the bridge is designed to carry necessitates a weight of cables and suspended superstructure that makes this the heaviest suspension bridge in existence, and, for its length, by far the heaviest and strongest bridge yet constructed.

The increased strength and decreased weight secured for this structure by the employment of Nickel Steel are factors of high importance, for without the use of Nickel Steel the construction of the bridge would necessarily have presented problems of greatly increased difficulty, owing to the remarkable weight of the structure.

The approximate saving in the weight and cost of bridges effected by the use of Nickel Steel is shown in the following table:—

Mixed Nickel and Carbon Steel:—
- Saving in Weight up to 25 per cent.
- Saving in cost up to 17 per cent.

Nickel Steel throughout:—
- Saving in weight 10 to 30 per cent.
- Saving in cost up to 12 per cent.

In addition to the applications to which Nickel Steel is being put in armour-plate, gun forgings, propeller shafts and other marine shafting, and in structural Steel-work, it has a wide field of employment in the manufacture of heavy castings, car-couplers, car-wheels, boiler-plates, pinions and knuckles, shear-knives, gears for motors, bicycle spokes, etc. Nickel Steel has proved itself so much superior to the older forms of Steel that it is recognised as unrivalled for these and similar purposes—in a word, for practically all kinds of work demanding hardness, toughness and malleability.

The increased strength and decreased weight secured by its employment, render Nickel Steel specially suitable for the manufacture of crank-pins, light forged engine frames, bolts for extreme hydraulic pressure, hydraulic forged cylinders, feed-water heaters, axles for rolling-stock, and various other purposes in which these qualities are essential.

It is especially valuable for motor-car parts, owing to its high tenacity, great durability and remarkable co-efficient of expansion.

For the same reason Nickel Steel is particularly well adapted as a material for the manufacture of Steel rails, and in sections where railway lines are liable to special stress it is used to great advantage. For instance, it is estimated that in a sharp curve one Nickel Steel rail has a life as long as that of four rails made of ordinary Steel.

Nickel Steel is also used for making wire cables, torpedo defence netting, electric lamp wire, umbrella wire, corset wire, mountings for lenses, mirrors, balances for clocks, weighing machines, springs, cutlery, harness mounting, boiler tubes, brakebeams and transoms for field artillery wagons, as used by the French Army since 1898.

Plates of Iron or Steel and Nickel, when laid together and heated to welding temperature, may be rolled out into thin plates with a continuous Nickel surface on both sides, or Nickel on one side and Iron or Steel on the other. Moreover, the union of the two metals is not merely a welding, but is of the nature of cementation, an actual alloy being formed to some depth below the surface of contact. It is found that ships sheathed with this material do not foul or corrode where so sheathed, even after months of constant service and continued exposure to the action of salt water.

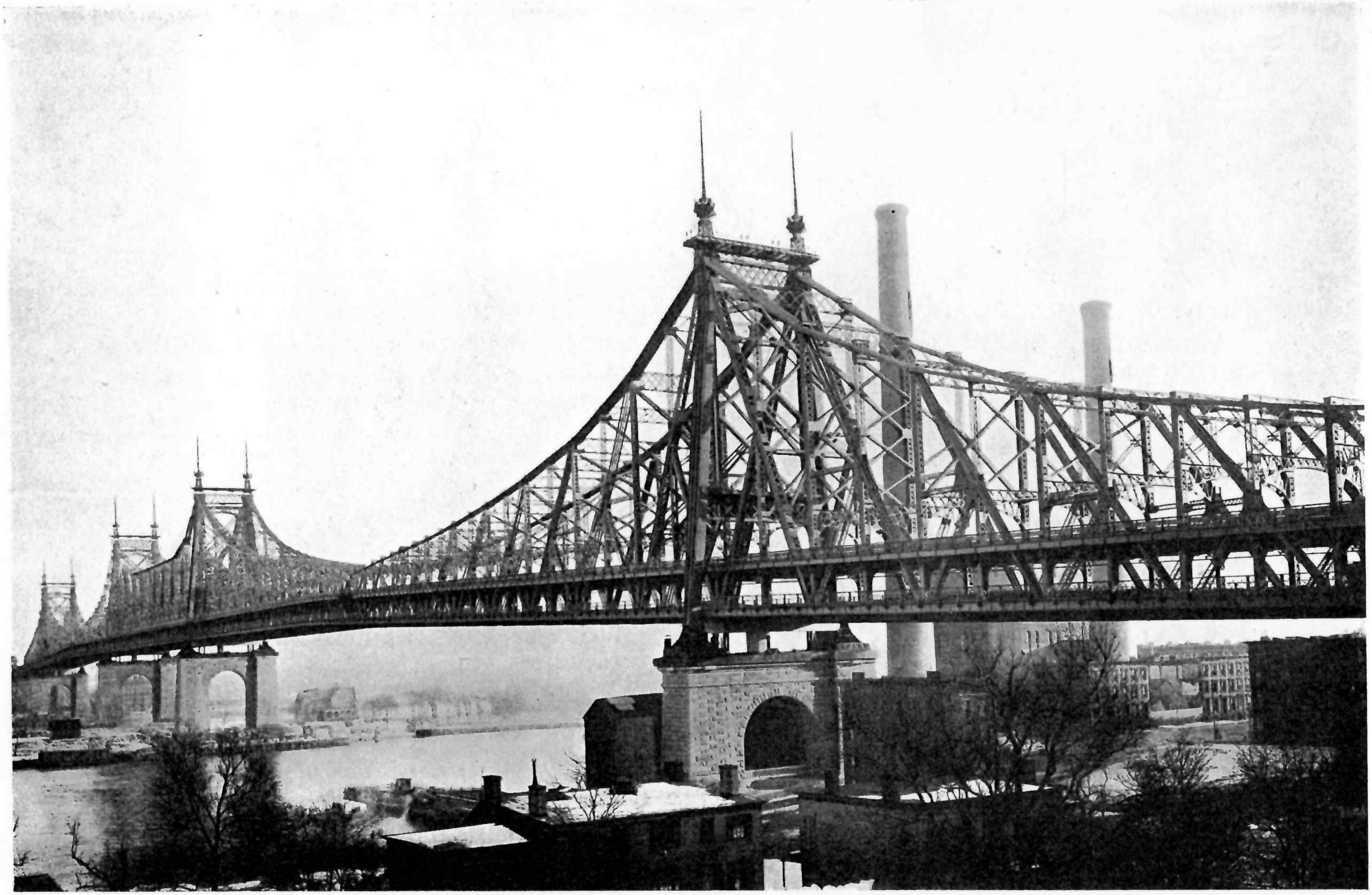
Nickel Steel containing as much as 30% of Nickel may be drawn into wire as easily as ordinary Steel. Wire of this class, containing sufficient Nickel to make the non-corroding qualities of the metal prominent, is especially adapted for hawsers and cable-service in salt water. The high tensile strength of such wire, accompanied, as it is, by a comparatively small reduction in elongation and contraction of area, indicate the extreme toughness of the material; and as, at the same time, the wire is not acted upon by salt water, it admirably fulfils the requirements of marine service.

There is a highly useful alloy of Iron and Nickel which is known as Invar, owing to the fact that it suffers no appreciable variation of length for ordinary variations of temperature. It contains 36% of Nickel and 0·2% of Carbon. It has a guaranteed co-efficient of expansion as low as 0·000,000,8. It is for this reason very useful for making tapes used in surveying, and for many other purposes. It is well suited for making clock pendulums, especially those used in hot countries.

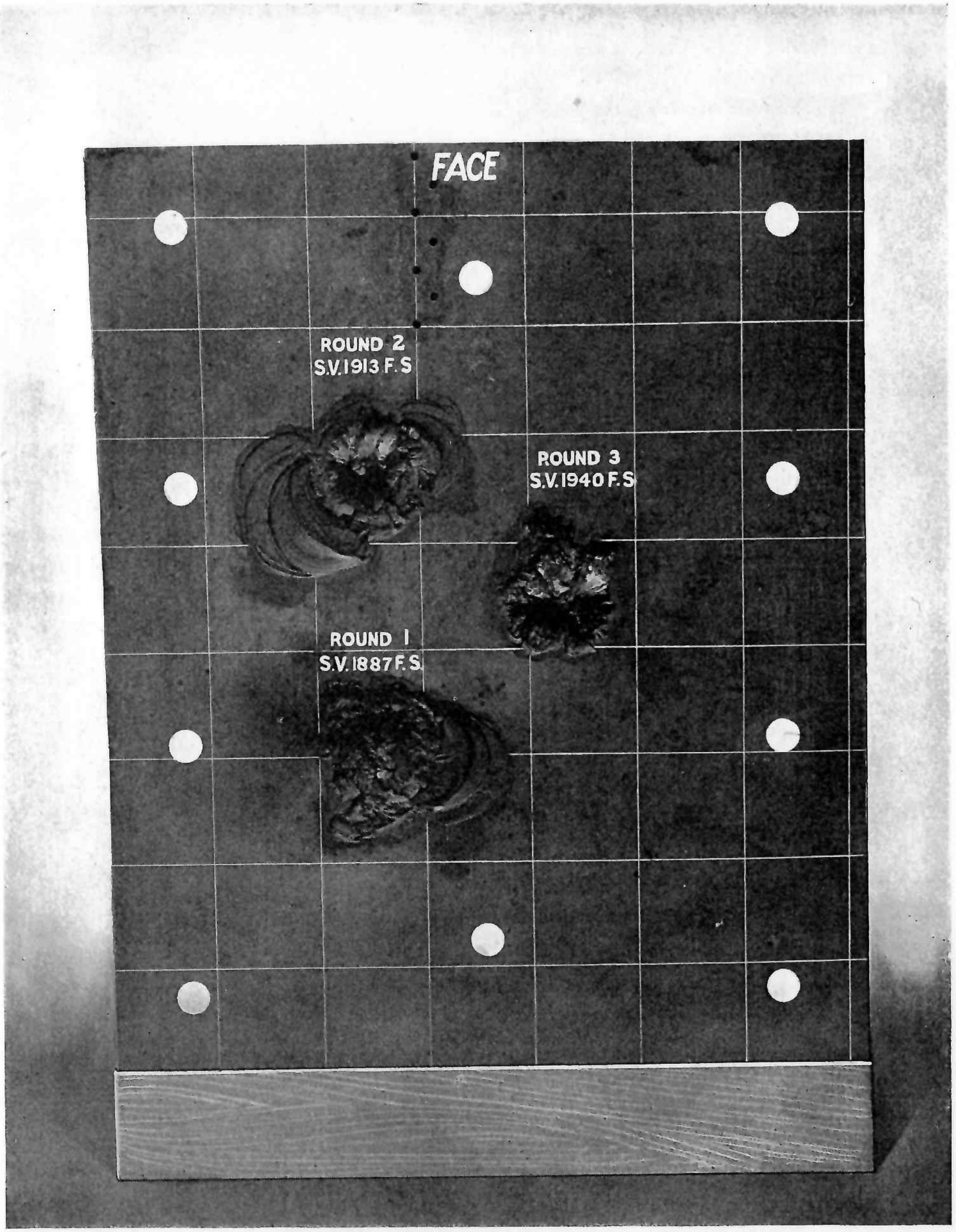
Nickel Steels of the Invar type, containing more than 24 per cent. of Nickel are characterised by a low degree of magnetic permeability, and some of them are practically non-magnetic at ordinary temperatures. They are used for electrical resistance.

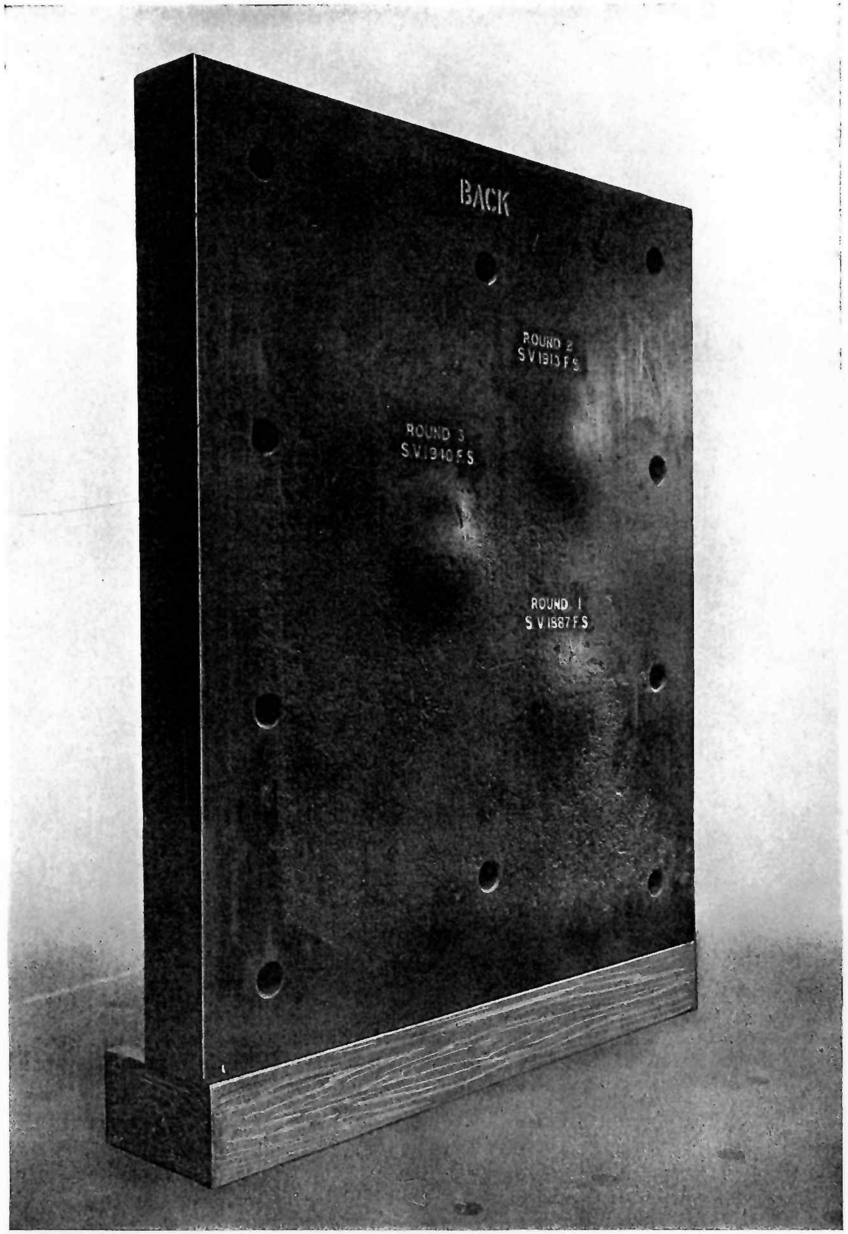
Another alloy, known as Cupro-Nickel, is used for making bullet-jackets, for which purpose it is admirably adapted on account of its non-corrosive qualities. It contains 85% of Copper and 15% of Nickel.

It will be obvious from the foregoing particulars—which do not attempt to do more than afford a brief summary of the present status of Nickel—that the already recognised and established uses of this remarkable metal are both numerous and of great variety. The field for its future employment is undoubtedly one of great magnitude, for the era of its development is still in its early years.



THE QUEENSBORO' BRIDGE, QUEBEC, CANADA.





ARMOUR PLATE FOR BATTLESHIPS.

One of the most important uses of Nickel is its employment in the manufacture of Armour Plate. These two illustrations show obverse and reverse views of Armour Plate in which MOND NICKEL was used, as it appeared after Official Tests by the British Government.

THREE REMARKABLE LARGE CALIBRE

ARMOUR-PIERCING PROJECTILES

PROJECTILES MADE FROM NICKEL STEEL

Manufactured by Hadfield, Ltd., Sheffield

MOND NICKEL USED FOR NICKEL STEEL

LEFT-HAND PROJECTILE.

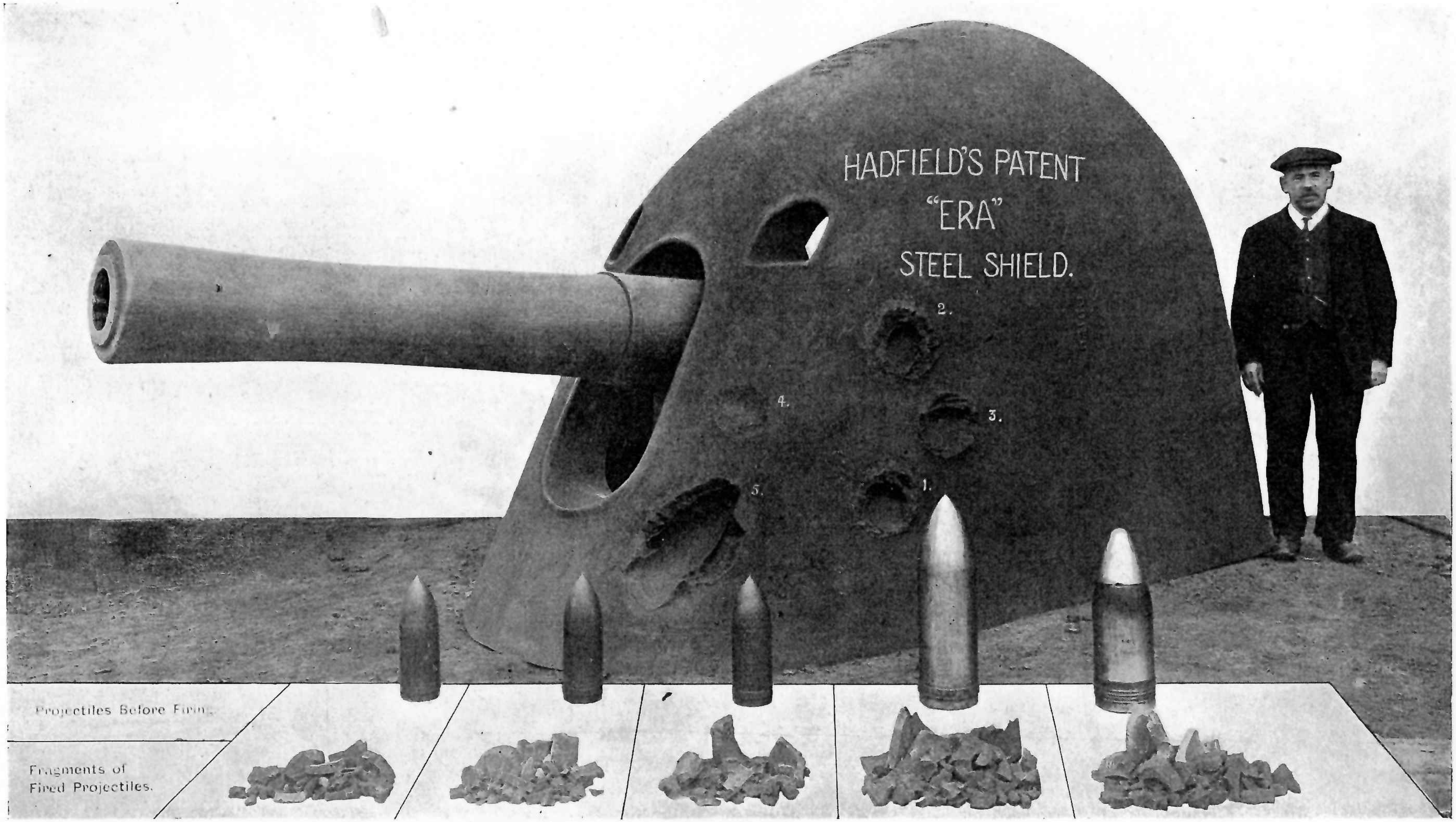
This Armour-Piercing Projectile is of 12 in. calibre, and weighs 860 lbs. Equipped with its patent cap, it was fired against a 12 in. Hard-Faced Plate, at a velocity of less than 1,700 ft. per second—equivalent to a range of about 6¼ miles. The Projectile perforated the 12 in. Plate, the Skin Plate, Backing and Target, and was recovered, *unbroken*, at a distance of more than 2 *miles* beyond the target.

CENTRE PROJECTILE.

This Projectile is a 14 in. shell of large bursting capacity, shown, after perforating, *unbroken*, a 6 in. Hard-Faced Plate of one of the latest types. Fired at the low velocity of 1,120 ft. per second, it passed through the Plate, Backing 24 ft. of sand-butt, and was recovered, unbroken, about a quarter-of-a-mile beyond the butt.

RIGHT-HAND PROJECTILE.

This Projectile is a 14 in. Armour-Piercing Capped Shot. Fired at a velocity of 1,497 ft. per second, it not only perforated, *unbroken*, a 12 in. Hard-Faced Plate, but also passed through no less than 20 ft. of sand-butt. This extraordinary performance, at an extremely low velocity, is equivalent to the perforating, unbroken, of a 12 in. Plate, by this remarkable Projectile, fired from a gun at a range of 7½ miles.

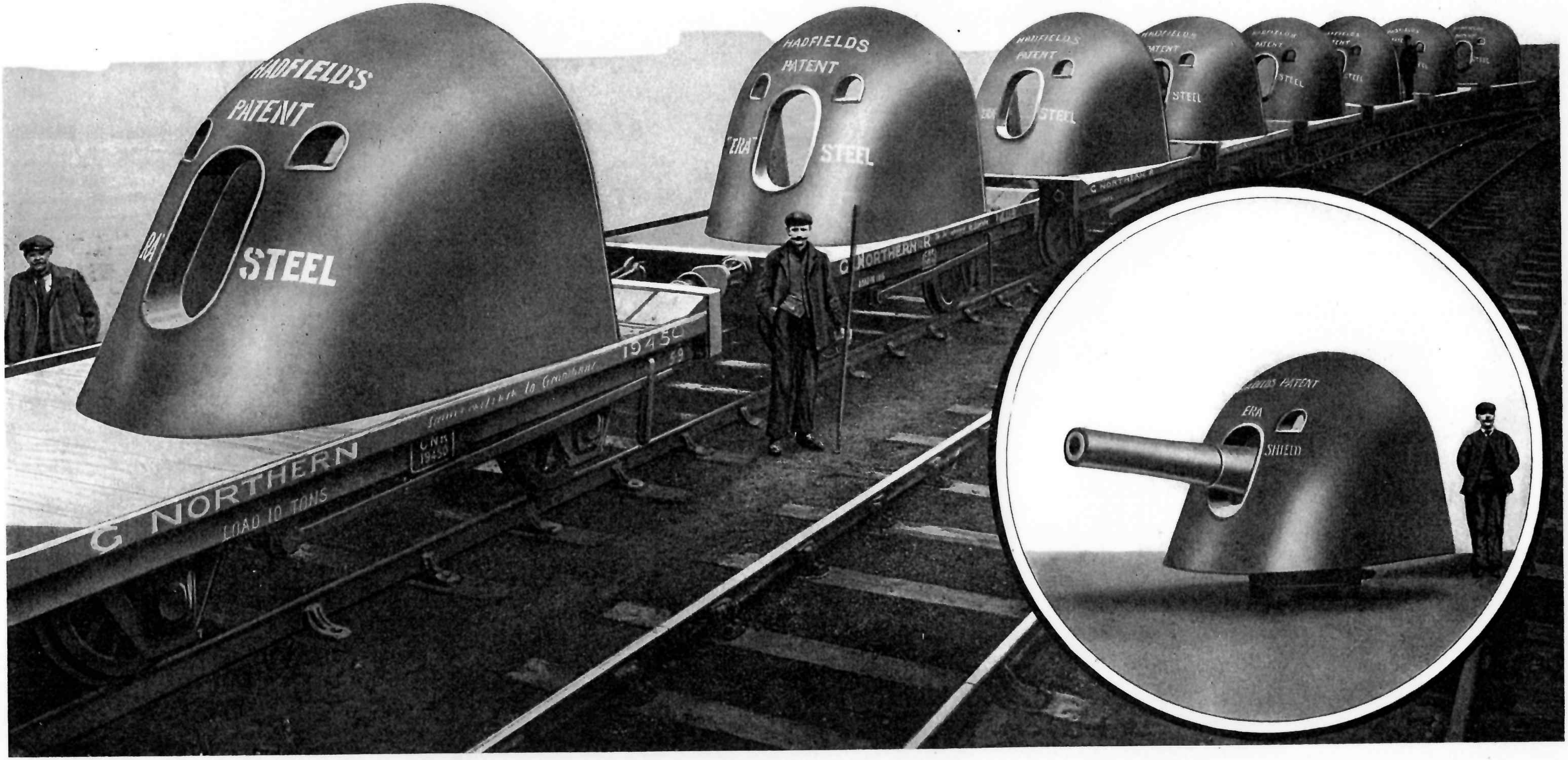


Particulars of the Rounds Fired:—	Round No. 1 4·7 inch Armour Piercing Shell	Round No. 2 4·7 inch Armour Piercing Shell	Round No. 3 4·7 inch Armour Piercing Shell	Round No. 4 6 inch Common Shell	Round No. 5 6 inch Armour Piercing Shot Fitted with Cap

PROJECTILES MADE FROM NICKEL STEEL.

Manufactured by Hadfield, Ltd., Sheffield.

MOND NICKEL USED FOR NICKEL STEEL.



NICKEL STEEL FOR ORDNANCE.

A Consignment of Shields for Carriage, Garrison, B.L. 6 inch Guns. These Shields are all made from Nickel Steel.

CANADIAN OFFICIAL PHOTO.] [REPRODUCED FROM PHOTO PURCHASED FROM THE TOPICAL PRESS AGENCY.

ARMOURED CARS.

NICKEL STEEL IS USED IN THE MANUFACTURE OF ARMOUR PLATES, WITH WHICH ARMOURED CARS AND "TANKS" ARE PROTECTED.

CAST NICKEL STEEL FOR ORDNANCE.

Nickel Steel is used in the manufacture of large Tubes and Director Towers for Battleships. This illustration shows Ammunition and Communication Tubes, and Director Towers as supplied by Hadfield, Ltd., Sheffield, to the British Admiralty for His Majesty's Ships: "Lord Nelson," "Agememnon," "Indomitable," "Inflexible," "Minotaur," "Shannon," "Defence," etc.

Reading from centre outwards, the following Steel Tubes are shown:

Two Communication Tubes, 35 ft. in length, 3 in. in thickness, 30 in. inside diameter.

Two Communication Tubes, 33 ft. in length, 4 in. in thickness, 30 in. inside diameter.

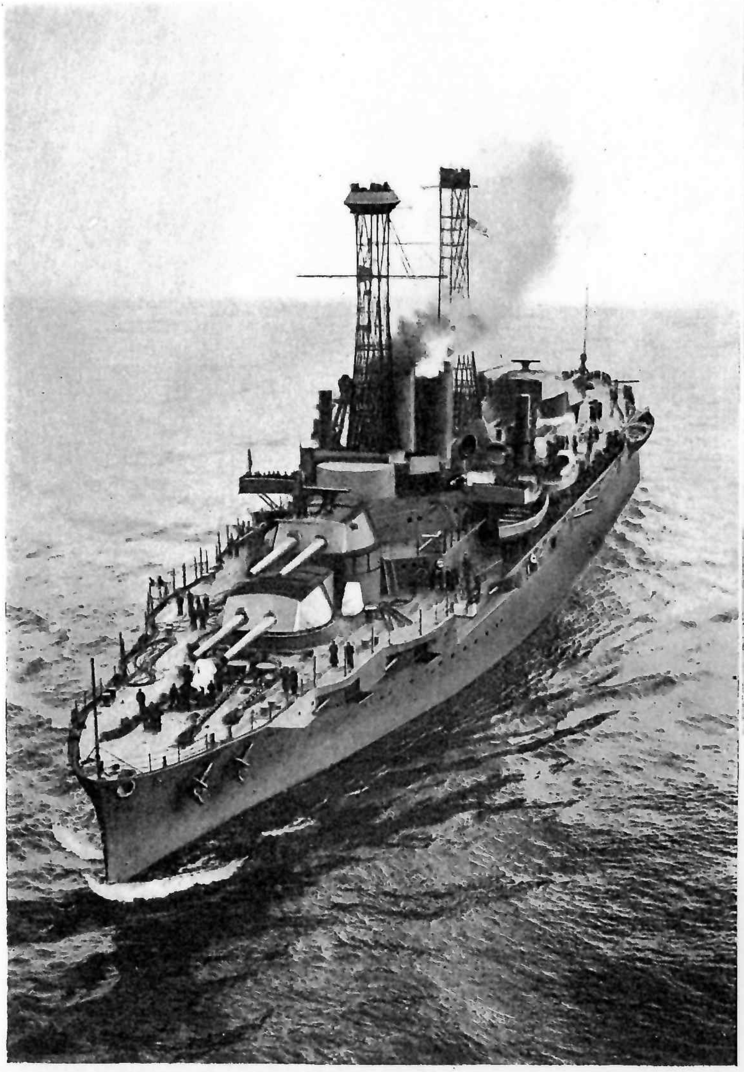
Two Communication Tubes, 25 ft. in length, 6 in. in thickness, 30 in. inside diameter.

Two Ammunition Tubes, 13 ft. in length, 3 in. in thickness, 15 in. inside diameter.

Two Ammunition Hoist Tubes, 11 ft. in length by 7 in in thickness.

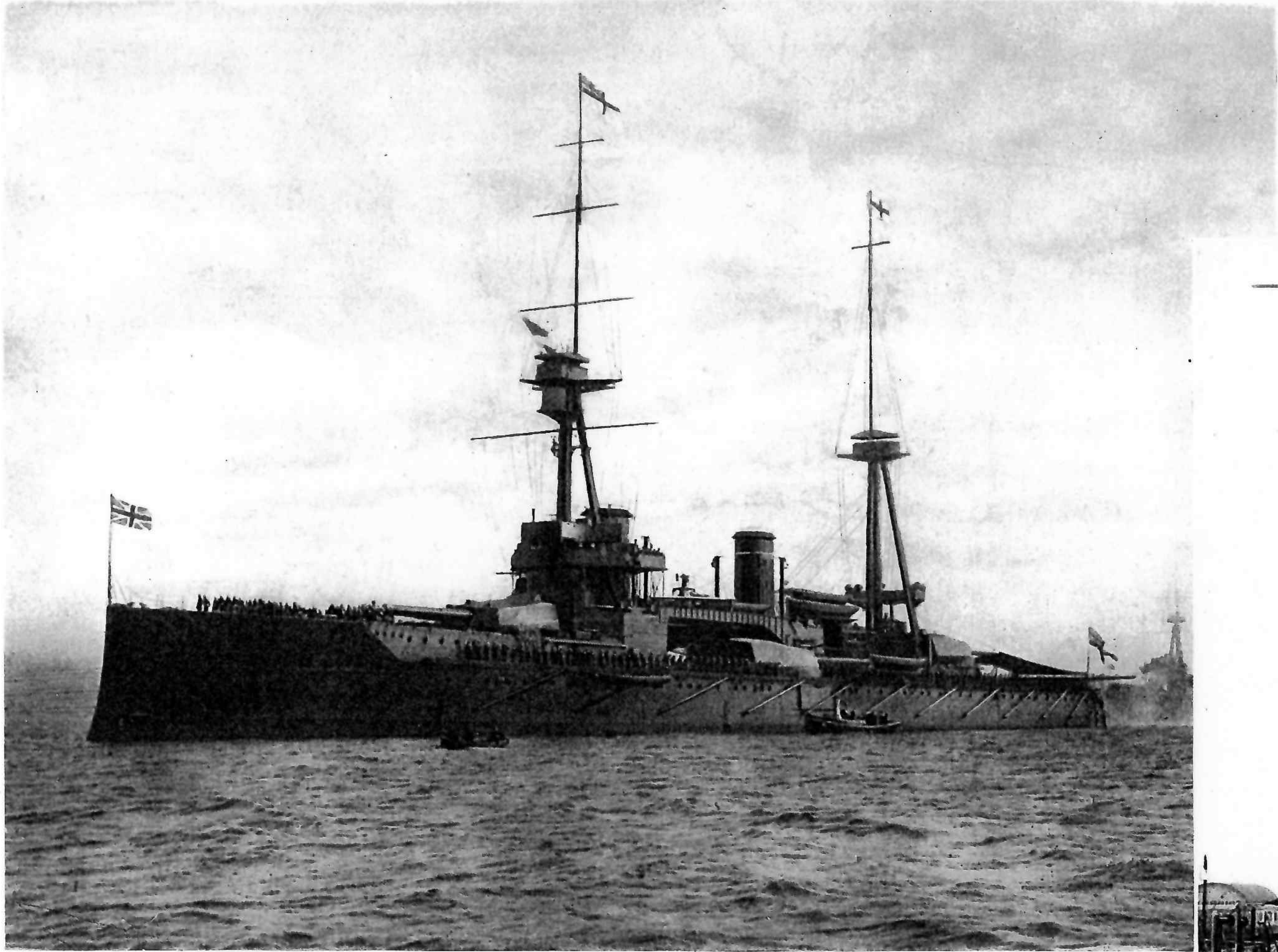
In the foreground are shown two Director Towers for H.M.S. "Minotaur" and "Defence" respectively.

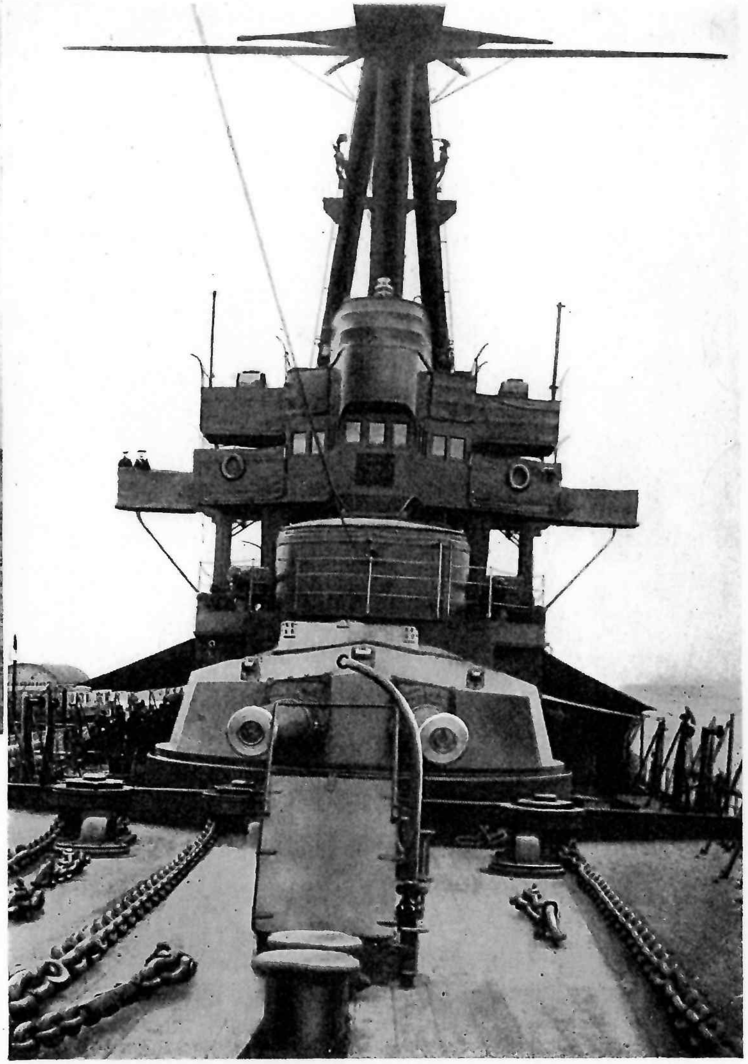
MOND NICKEL USED FOR NICKEL STEEL.



BATTLESHIP.
View of Guns.

BATTLESHIP.
General View.





50 Centimes. 1 Franc.
GUADELOUPE, 1903.

1 Penny. 1 Half-penny. 1 Farthing.
JAMAICA, 1869.

1 Centavo. 3 Centavos.
SALVADOR, 1889.

2½ Centesimos. ½ Centesimo.
PANAMA, 1907.

1 Farthing (1887). 1 Half-penny (1887). 1 Penny (1887).
JAMAICA, 1869.

5 Cents.
BRITISH HONDURAS, 1907.

5 Cents.
HOLLAND, 1907.

Nickel Coinage

The accompanying illustrations are reproductions of representative specimens from the Mond Nickel Company's collection of Nickel Coins of the World. The name of each Country is followed by the date of introduction of Nickel Coinage into that Country. The dates shown in parenthesis refer to a particular issue.

A GREAT many countries have adopted Nickel or Nickel alloy for the manufacture of small currency for the reason that Nickel is the one metal which completely fulfils all the requirements of such currency.

The subject of coinage is one of great importance and of special interest at the present time, when the introduction of new uniform coinage throughout the British Empire is contemplated.

The Dominions Royal Commission urges the introduction, at the earliest practicable date, of a new and uniform system of coinage for circulation throughout the British Empire.

The Report, recently issued, emphasizes the fact that a considerable body of serious opinion in the various British Dominions is in favour of such a course, in regard to which the Commissioners state:

> We have studied the discussion on the subject of currency and coinage laws at the Imperial Conference of 1911, and have also heard evidence from the representatives of the Decimal Association and witnesses in the Dominions as to the desirability of introducing metrical weights and a new style of coinage based on the decimal system.
>
> The general advantages of these systems are recognised; the complications of the present arrangements, both in the United Kingdom and in several of the Dominions, are such that very few would undertake to defend their principles. . . .
>
> We are of opinion that the termination of the war will bring with it an unequalled opportunity for securing this much-needed reform, and we recommend that Your Majesty's Government and the Governments of the oversea Dominions should then co-operate to establish throughout the British Empire a uniform coinage based on the decimal system.—(Final Report of the Royal Commission on the Natural Resources, Trade, and Legislation of Certain Portions of His Majesty's Dominions. [Cd. 8462] 1917, p. 158, pars. 711 and 713.)

Such a reform as is implied in this official report is one which has been long overdue, and the multitudinous advantages which would inevitably proceed from its introduction are of such a nature as ultimately to outweigh entirely any disadvantages arising in the early period of its inception. Coinage on the decimal basis has been in use for some time past in various parts of the British Empire, including Canada, Newfoundland, Egypt, the Straits Settlements, and adjacent possessions, Ceylon, British East Africa and Uganda, and many other of our smaller possessions.

RÉUNION, 1896.
50 Centimes. 1 Franc.

BRAZIL, 1890.
400 Réis. 200 Réis. 100 Réis.

5 Chon. ¼ Yang. KOREA, 1902.

5 Millièmes (1916). 10 Ochr-el-guerche. 5 Ochr-el-guerche. EGYPT, 1886.

5 Sen. JAPAN, 1889.

5 Paras. 10 Paras. 20 Paras. TURKEY, 1911.

2 Ochr-el-guerche. 1 Ochr-el-guerche. EGYPT, 1886.

1 Shâhi. 2 Shâhis. PERSIA, 1900.

TOKEN CURRENCY OR SUBSIDIARY COINAGE

A very large portion of all the existing monetary systems of the world necessarily takes the familiar form of token currency (*i.e.*, subsidiary coinage, or representative money), the value of which is fixed by law at a conventional rate considerably in excess of its intrinsic value.

Credit currencies of conventional value are fully justified by practical considerations.

If the nominal value of token coins were equal to their intrinsic value, it would necessitate the production of inconveniently small coins, easily lost, incapable of withstanding wear, and therefore of rapid depreciation. A prohibitive loss of interest on cost price would, therefore, automatically result. On the other hand, should the intrinsic value exceed the nominal value, circumstances might conceivably arise—such as crises of a commercial or financial nature—which would offer a strong incentive to withdraw such coins, for purposes of export or melting down. The nation, and particularly the poorer classes, would be placed at a grave disadvantage by such procedure.

The only serious consideration that can be urged against a currency of conventional value is the inducement which it offers to counterfeiters, owing to the difference between its intrinsic and nominal values. There are, however, practical means by which this disadvantage is reducible to a negligible minimum :

Firstly, by selecting a metal for token currency which is difficult and costly to counterfeit ; and

Secondly, by utilising an artistic type of coin, requiring considerable delicacy and minuteness in execution.

The manufacture of authentic coins of this character necessitates the employment of such complex and perfect machinery involving so large a capital outlay, and plant of such considerable dimensions, as to preclude, on practical grounds, the illicit manufacture of the coins, and at the same time to involve attempts in this direction in difficulties and risks out of all proportion to the profits arising therefrom.

SELECTION OF SUITABLE METAL

Practical utility being the prime desideratum of credit currency, it is necessary that the metal, or alloy, adopted for the manufacture of subsidiary coinage should be selected from the standpoint of all-round usefulness rather than that of intrinsic value. In order to meet adequately the demands to be made upon it, the metal must comply with the following major requirements :

It must be comparatively inexpensive, and yet of pleasing appearance, and it must resist oxidation as much as possible ; it must be easy to melt, roll, blank and strike ; it must be sensitive to the impression of the die, durable in use, and difficult to counterfeit.

Formerly Copper or Bronze were most frequently used for subsidiary coinage of low value in nearly all countries. They are cheap and easy to work, but very liable to oxidization and are too soft.

MEXICO, 1906. 5 Centavos.

PHILIPPINES, 1903. 5 Centavos.

U.S.A., 1866. 5 Cents.

KIÃO-CHAU 1909. 10 Cents. 5 Cents.

25 Centimes (1903-1913). 25 Centimes (1914).

FRANCE, 1903.

20 Bani. 10 Bani. 5 Bani.

ROUMANIA, 1905.

2½ Stotinki. 5 Stotinki. 10 Stotinki. 20 Stotinki.

BULGARIA, 1888.

Nickel Silver.—This alloy of Nickel, Copper and Zinc has been used for coins in various States of South America. Although better than Copper and Bronze, it oxidizes too readily and soon loses its bright appearance.

Nickel Silver, with an addition of pure Silver, was tried by the Swiss Government, but the coins made of this alloy soon became yellowish and unsightly, and Switzerland has since adopted pure Nickel for its coinage.

Small Copper coins coated with Silver have been used in many countries, but the Silver coating soon disappeared and the appearance of the coins became so paltry, and dirt adhered to them to such a degree, that many countries in which they were in use discarded them altogether.

Aluminium.—Aluminium coins have proved a great failure. In 1906 the British Government decided to introduce subsidiary coinages of Aluminium for circulation in Nigeria, British East Africa and Uganda. The coins, which were of small denominations, comprised 1/10th-penny pieces for Nigeria, and cents and ½-cents for British East Africa and Uganda. In 1907 over 1¼ million pieces were coined for Nigeria, and about 7 millions for British East Africa and Uganda. In 1908 over 8½ million pieces were coined for Nigeria, and about 3¾ millions for British East Africa and Uganda. The total number of these Aluminium coins thus circulated in the three Protectorates during the two years was 20,336,000 pieces, of a nominal value of £10,850. These coinages only survived two years. Even during this short period the coins became very badly corroded and, in general, proved themselves to be entirely unsuited to a warm climate. The whole of these Aluminium currencies were, therefore, withdrawn by an Order of 1910, and were replaced by Nickel-Bronze coins in the following year.

Similarly unsatisfactory results attended the prolonged researches of French experts as to the suitability of Aluminium. On August 27, 1909, M. Cochery, the Minister of Finance, appointed a Commission of scientists, under the presidency of M. Voille, to enquire into the advantages and disadvantages of Aluminium as a medium for currency. The Commission closed its enquiry in 1910, having arrived at the following conclusions :—

> Neither pure Aluminium nor any form of Aluminium slightly alloyed gives a superior resistance to shocks and friction than that offered by Silver, which resistance is insufficient for small coinage ; moreover, none of the alloys offers resistance to the prolonged action of the usual chemical agents.

Cupro-Nickel.—This is an alloy of Copper and Nickel, and it was first tried by the United States and Belgium. The grades of which trial was made varied from 90% of Copper and 10% of Nickel up to 50% of each of the two metals. The experiences of the United States and Belgium, and subsequently of Germany and other countries have led to the conclusion that the Cupro-Nickel alloy most nearly fulfilling the requirements of credit currency is one composed of 75% of Copper and 25% of Nickel. Coins made from this alloy are of pleasing appearance and the prime cost of manufacture is not excessive. They

½ Centavo. 1 Centavo. 2 Centavos. 5 Centavos.

ECUADOR, 1884.

GERMANY, 1873.

5 Pfennig. 10 Pfennig. 25 Pfennig. 20 Pfennig (1887-1900).

ECUADOR, 1884.

½ Decimo.

5 Centimes. 10 Centimes.
LUXEMBOURG, 1901.

10 Cents. 1 Cent. ½ Cent.
BRITISH EAST AFRICA AND UGANDA, 1907.

COSTA RICA, 1903. 2 Centimos.

COLOMBIA, 1874. 1 Peso. 2 Pesos. 5 Pesos.

SIAM, 1898. 5 Satangs. 10 Satangs.

ITALY, 1894. Centesimi (1894-1901). 20 Centesimi.

offer great resistance to oxidization, and they are sufficiently hard to be worked with difficulty, and to offer satisfactory resistance to the wear and tear of circulation.

Whilst Cupro-Nickel is, admittedly, more costly than Copper or Bronze, it has the counterbalancing advantage that coins manufactured from it can be made of smaller size than those of Copper and Bronze of equal value. Moreover, Cupro-Nickel coins are not only difficult to counterfeit, but the comparatively high price of this alloy and the manual skill and machine-power necessary to work it, combine to present such difficulties and discouragements to illicit coiners that up to the present time no successful counterfeiting operations of serious proportions have come to light.

Pure Nickel.—With a view to obtaining a coinage which would alike be secure against the efforts of counterfeiters, and by its nature ensure for itself a long period of circulation, the Swiss Government employed pure Nickel in 1881 for the manufacture of the 20 centimes piece. The new coins rapidly achieved success, and Nickel currency was introduced by various other countries, including Austria-Hungary, Denmark, France, Germany, Italy, Montenegro, Mexico, and others.

Nickel offers an opportunity for the adoption of a lighter, cleaner and more resistant coinage than is possible from the use of Copper or Bronze, and one of very superior appearance. There is undoubtedly no coin of low currency-value which looks so well. Characterised by great brilliance Nickel takes the impress of the die with a distinctness unapproachable by any other metal less costly than Silver. Possessing the essential qualities of hardness and unalterability, Nickel coins are light in weight, do not oxidize, and offer no danger of becoming poisonous.

As regards the possibility of counterfeiting, the hardness of the metal offers an almost insuperable obstacle to unauthorised coiners. It requires expensive plant and machinery to prepare discs of pure Nickel, and the technical difficulties are such that it is in the highest degree improbable that any person possessing the knowledge and capacity necessary for the production of pure Nickel coins would become a counterfeiter. Nickel coins are magnetic, whereas Nickel-Copper coins are not. The genuineness of Nickel coins is therefore open to a ready means of testing.

One of the principal considerations which induced Italy to effect a change from Copper-Nickel to pure Nickel coinage was that a very large number of counterfeit Copper-Nickel coins was found to be in circulation, without it being possible to detect their source. An alloy of 25% has been legalised in Italy in 1894. This was replaced by pure Nickel in 1902. Similarly, the introduction of Nickel-Copper coins into Korea, which was commenced in 1902, came to a standstill, owing to the fact that the country was inundated with spurious coins made in Japan.

The hardness of pure Nickel ensures the durability of the coinage. So durable, indeed, is this metal that Swiss pieces of 20 centimes which have been in circulation for more than 30 years show practically no deterioration from wear and tear.

HAITI, 1897.
5 Pesos (1904). 5 Pesos. 50 Pesos. 20 Pesos. 10 Pesos.

1 Centésimo. 2 Centésimos. 5 Centésimos. 20 Paras. 10 Paras.

URUGUAY, 1901. SERBIA, 1884.

5 Centimes. 25 Centimes. BELGIUM, 1860. 10 Centimes.

5 Centimes. 20 Centimes. BELGIAN CONGO, 1906. 10 Centimes.

The wear of coins in circulation is a far more complex matter than was formerly understood. This question is referred to in a Memorandum appended to the Annual Report of the Deputy Master and Controller of the Royal Mint, London. (Forty-fifth Report, 1914, p. 54):—

"The good wearing qualities of Copper-Nickel alloys," say this authority, "are no doubt to be attributed to the fact that they form homogenous solid solutions. *A pure Metal, such as nickel, offers still more resistance to chemical attack.* . . . . There is little doubt that the rapid loss of weight of a new coin is due to abrasion, but when the rough edges have been removed in the course of the first few months of circulation, it is well known that a change in the condition takes place and *chemical action may prove to be of the first importance in the succeeding years.*"

The cost of the metal for making the blanks, and of striking the coins is slightly more for Nickel than for Cupro-Nickel, but the advantages of using pure Nickel go far to offset the difference in initial expense. Furthermore, the enhanced life of pure Nickel coins is equivalent to a valuable reduction in the prime cost of the metal and its manufacture into coinage.

Another important advantage of Nickel Currency is the steadiness in the price of the metal, whereas the price of Copper has, during the past thirty years, been subject to continual fluctuations. Owing to the rise in the price of Copper, Copper coins have simply disappeared from trade in some countries, such, for instance, as Persia, Turkey and China.

It will be apparent from the considerations reviewed that the substitution of pure Nickel in place of Cupro-Nickel and Bronze for purposes of subsidiary coinage, is a progressive step of so beneficial and so practical a nature that we may confidently look to the future to transform anticipation into an accomplished fact.

WORLD'S NICKEL CURRENCY

The first legal enactment in regard to Nickel Coinage is that of Switzerland, 7 May, 1850, and the Swiss Government were the first to use coins of pure Nickel, which, as stated, they issued in 1881. The use of Nickel for coins appears however, to have been first suggested in the United States, and under an Act of 21 February, 1857, Nickel-Bronze coins were issued in that country concurrently with those of Copper. These coins were Nickel-Bronze cents, containing 12% of Nickel and 88% of Copper. The number issued is unknown. They remained in circulation seven years. It may be added that Nickel was regularly used in Belgium in 1861, when coins of 20, 10 and 5 centimes were issued in the alloyed metal. The latest official figures for the Nickel and Nickel-Bronze coinages of the world are those down to the end of 1912.

The number of pure Nickel coins issued to the close of 1912 exceeded 909,000,000, of which about 13,250,000 Italian 25 centesimi pieces were withdrawn at the end of that year, the number of pure Nickel coins in circulation at the end of 1912 being 895,920,035.

BELGIUM, 1860. PORTUGAL, 1900.

5 Centimes (1860-1903). 10 Centimes (1860-1903). 20 Centimes (1860-1903). 100 Reis. 50 Reis.

10 Lepta. 5 Lepta (1912). 1 Penny. $\frac{1}{10}$ Penny. 10 Centimes.

GREECE, 1893. BRITISH WEST AFRICA, 1907. SWITZERLAND, 1887.

5 Lepta. GREECE, 1893. 20 Lepta.

20 Lepta CRETE, 1900. 5 Lepta.

5 Centimes. SWITZERLAND, 1887. 20 Centimes.

12½ Centimos (1896). VENEZUELA, 1876. 5 Centimos (1896).

Of the total issues, 79·7 per cent. forms the sole Nickel currency in three States (62% being in Austria-Hungary), and 16·9 per cent. used in conjunction with Nickel-Bronze.

The issues of Nickel-Bronze coinages throughout the world to the end of 1912 exceeded 4,543,000,000, of which about 407,000,000 had been withdrawn in Belgium, Germany, Italy and Korea. The balance in circulation at the end of that year was 4,136,851,348 (*vide* Forty-fourth Annual Report of the Mint, 1913, pp. 90-91).

In Austria-Hungary, where progress in the working of Nickel was made at an early date, this metal in the pure state has been coined and issued regularly since 1892.

In France, pure Nickel was adopted, for 25 centimes only, in 1903. Ten years later, however, a law, signed on August 5, 1913, provided for the withdrawal of these coins and of the Bronze currency, and for gradually replacing them during the ensuing ten years, with the following coins, all of pure Nickel :—

Denomination.	Millions of Pieces.
25 Centimes	120
10 ,,	300
5 ,,	400
	Total 820

Deducting 25 centime pieces to be withdrawn, to the number of 40 million, the total new issue of French coins of pure Nickel will be, upon completion, 780,000,000. A Decree of July 10, 1914, determined the design of the new Nickel coins conformably to the models executed by M. Lindauer.

In Germany between 1873 and 1916 Nickel coins had been issued to the value of about 120 million marks, inclusive of withdrawals to the value of about 2½ million marks.

In the British Empire, the first Nickel coinage was that for Jamaica, in 1869, comprising pence, half-pence and farthings of 20% Nickel and 80% Copper alloyed. Up to the end of 1906 Jamaica remained the only Colony employing Nickel currency, about 8 million pieces having been struck up to that time. The rapid increase in popularity which Nickel coinage has achieved during recent years is evident from the fact that at the end of 1910 about 166 million Nickel-Bronze coins had been issued within the Empire, whilst only two years later, at the close of 1912, the number had risen to more than 326 millions. Therefore, during the six years, 1906—1912, an addition of 318 millions had been made to the Nickel-Bronze coinage in British Dependencies.

The following are official figures relating to the number of Nickel alloy coins struck in the Royal Mint from 1907 to 1914, inclusive, for West Africa, East Africa and Uganda, Ceylon and British Honduras :

1907	1,862,848	pieces.
1908	12,817,152	,,
1909	33,670,000	,,
1910	18,744,509	,,
1911	15,215,491	,,
1912	38,258,000	,,
1913	16,305,600	,,
1914	38,597,600	,,

CRETE, 1900. BOLIVIA, 1883.

10 Lepta. 5 Centavos. 10 Centavos. 10 Centavos (1883-1892). 5 Centavos (1883-1892).

F

10 Heller. 20 Heller. AUSTRIA, 1892.

1 Anna. INDIA, 1908.

20 Fillér. 10 Fillér. HUNGARY, 1892.

5 Centavos. 10 Centavos. 20 Centavos. ARGENTINA, 1909.

5 Cents. CEYLON, 1909.

¼ Real. ½ Real. 1 Real. GUATEMALA, 1900.

50 Centimes. MARTINIQUE, 1897.

Many of the pieces were struck under contract in years subsequent to 1910. The use of Nickel in currency has thus been of special interest to the Mint.

The following list shows the date of the introduction of pure Nickel coinage into the countries mentioned :

1881	Switzerland.
1892	Austria.
1901	Italy.
1903	France.
1910	Mexico.
1906	Serbia.

How widespread is the use of Nickel and Nickel alloy for small currency can be seen from the following list of countries which have adopted Nickel coinage.

Alaska.
Ashanti.
Argentina.
Austria.
Azores.
Belgian Congo.
Belgium.
Bolivia.
Brazil.
British E. Africa.
British Honduras.
British North Borneo.
Bulgaria.
Ceylon.
Colombia.
Costa Rica.
Crete.
Cuba.
Danish West Indies.*
Dutch East Indies.
Ecuador
Egypt.
France.
Gambia.
German East Africa.
German South-West Africa (late).†
Germany.‡
Gold Coast and Northern Territories.
Greece.
Guadaloupe.
Guatemala.
Haiti.
Hawaii.
Holland.
Honduras (Republic of).
Hungary.
India.
Italy.
Jamaica.
Japan.
Kiao-Chau.
Korea.
Luxembourg.
Madagascar.
Madeira.
Martinique.
Mexico.
Montenegro.
Nicaragua.
Nigeria.
Panama.
Paraguay.
Persia.
Philippines.
Porto Rico.
Portugal.
Reunion.
Rumania.
Samoan Islands.§
San Domingo.
Salvador.
Serbia.
Siam.
Sierra Leone.
Sudan (Anglo-Egyptian).
Switzerland.
Turkey.
Uganda.
United States of America.
Uruguay.
Venezuela.
Zanzibar.

Chili issued Nickel coins in 1875, and Peru made at least three issues, namely, in 1863, 1879 and 1880.

Trading Tokens made of Nickel have sometimes been issued privately by commercial concerns for use in certain countries, such, for example, as Curaçao (Dutch West Indies), and in the Colon territory (Panama).

Pure Nickel coins may be grouped as follows, according to their equivalents in English value :—

1d. ...	Austria-Hungary, Danish West Indies, Montenegro.
1¼d. ...	Mexico.
2d. ...	Austria-Hungary, Italy, Montenegro, Switzerland.
2½d. ...	France, Germany, Italy.
2⅓d. ...	Zanzibar.

* Ceded to U.S.A. March 31st, 1917.
† German coinage withdrawn in 1917, and British currency substituted.
‡ Nickel coins temporarily withdrawn till after declaration of peace (*Vide* "Chemiker Zeitung," April 4th, 1917, p. 289).
§ German coinage withdrawn from late German Samoa in 1917, and British coinage substituted.

PARAGUAY, 1900.

10 Centavos. 20 Centavos. 20 Centavos (1900-1907). 10 Centavos (1900-1907). 5 Centavos (1900-1907).

SIZE AND DESIGN AS SAFEGUARDS.

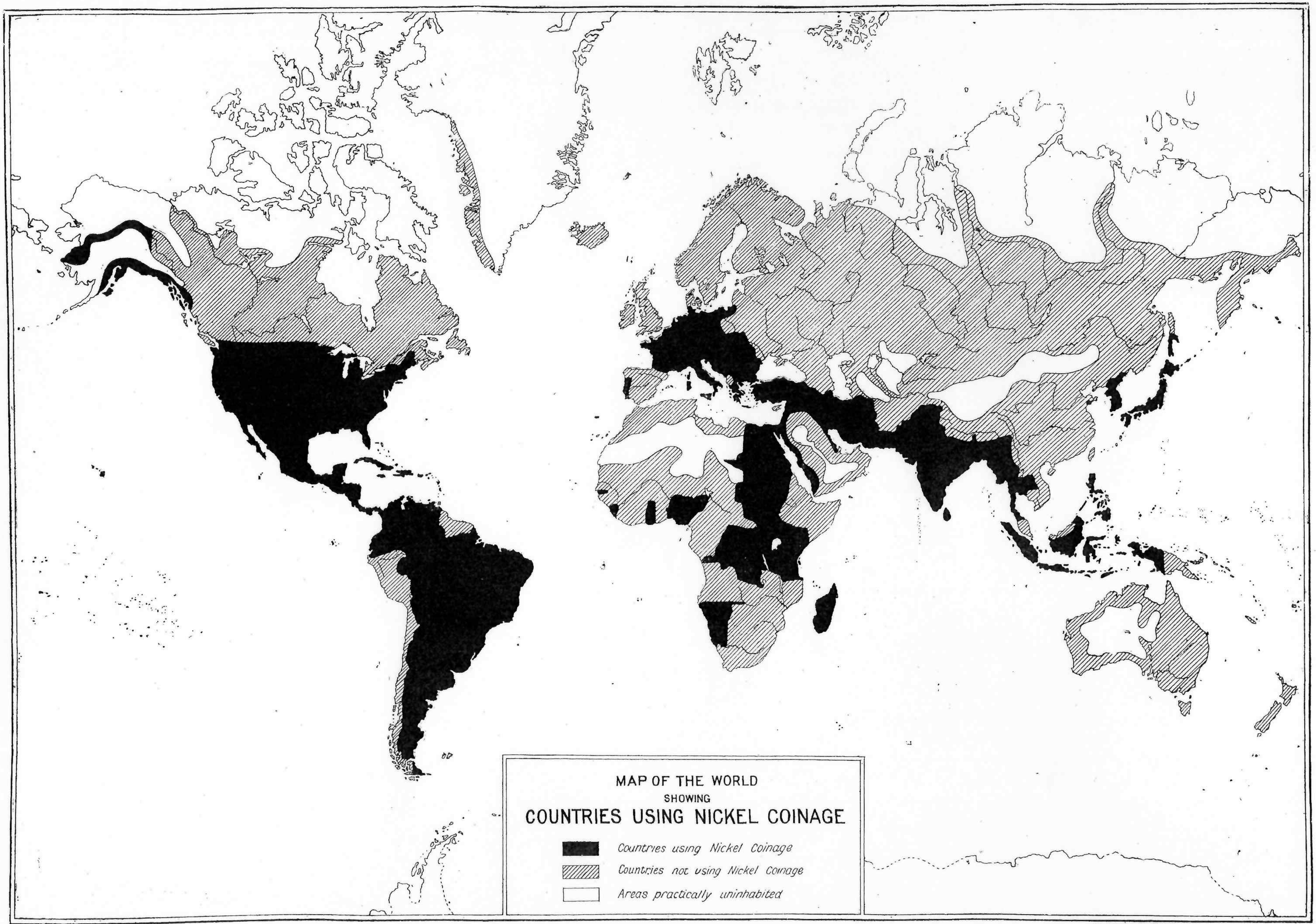
There are two major considerations which govern the dimensions of subsidiary currency of low value. The first is the ratio between diameter and thickness on the one hand, and the size, weight and conventional value on the other hand. The second is the relation between the coins in question and other coins of the same monetary system. The lower limit in size is governed by convenience. Coins that are easily lost or that are picked up with difficulty are unsuitable in size. On these grounds the British three-penny piece and the American gold dollar are not widely approved of by numismatists.

So far as concerns Nickel coinage, a lower limit of 16 mm. and an upper limit of 22 mm. have proved to be convenient dimensions.

As an instance of the economy effected by the use of Nickel coins, it may be pointed out that in the coinage of the British Isles alone, if Nickel were substituted for Bronze, in accordance with the recommendations of the Decimal Association, a profit of over half-a-million sterling would be made annually by the Chancellor of the Exchequer.

MONTENEGRO, 1883.

5, 10, and 20 Paras.



"GEOGRAPHIA" Lᵀᴰ 55 FLEET STREET. LONDON. E.C. 4.

Nickel Utensils

BRIEF reference has been made on a previous page to the fact that Nickel possesses chemical powers of resistance not greatly inferior to those of the precious metals themselves, whilst it is greatly superior to them in point of hardness and toughness. During recent years advantage has been taken of these characteristics, to utilise Nickel for the manufacture of numerous articles and hollow-ware for the purposes of the various technical arts, and also for the manufacture of high-grade culinary ware and cooking utensils in great variety. For these purposes, indeed, Nickel is an ideal metal.

Tinned, or "tin" vessels, which are made of sheet Iron coated with Tin, are usually thin, and very liable to injury. Enamelled vessels have the great drawback that the enamel coating is extremely liable to chip. When damaged enamel utensils are used the food comes into direct contact with the iron and is apt to acquire a metallic flavour. There is also the great danger that detached chips of enamel may be, and, indeed, frequently are, swallowed in the cooked food, thus giving rise to serious illness.

Copper cooking utensils undergo strong oxidation, and can only be used provided that they have a thick inside coating of tin. This coating wears away very rapidly and requires frequent renewal. There is, therefore, always the danger of the formation of poisonous copper salts which dissolve in the liquid food, and have on many occasions led to serious cases of poisoning. Under any circumstances, Copper utensils involve a great deal of work for the kitchen staff. Every time after use they must be not only washed but scoured, to remove the discolouration caused by the fire.

One of the chief advantages of Nickel kitchen utensils is that they do not require tinning. Every householder knows the expense and trouble involved in getting kitchen Copper-ware constantly retinned. The expense is, indeed, very great, whilst the retinning bills of large London hotels amount to very considerable sums. This recurring expenditure may now be entirely eliminated by the adoption of Nickel utensils.

AMERICAN EXPRESS DINING CAR.
L. & N. W. Ry. Co.
Nickel Kitchen Utensils.

Nor do cooking utensils made of Aluminium provide a satisfactory substitute for Copper or Iron. As the melting point of Aluminium is comparatively low, this metal is, of course, extremely sensitive to the action of heat, and vessels of Aluminium unfilled with water frequently melt if they are put on a strong gas flame or fire. Moreover, the constant recurrence of a dull grey layer of oxide necessitates continual scouring. This disadvantage is intensified by the fact that Aluminium, being exceedingly soft, requires specially careful and delicate handling in this operation. It must not, for instance, be scoured too vigorously with sand, nor must soap and water in which washing soda has been dissolved be used in cleaning it, because, in course of time, decomposition and gradually complete dissolution of the metal would take place.

Aluminium is also dissolved in liquid food and forms metallic salts which may sometimes be of a poisonous nature.

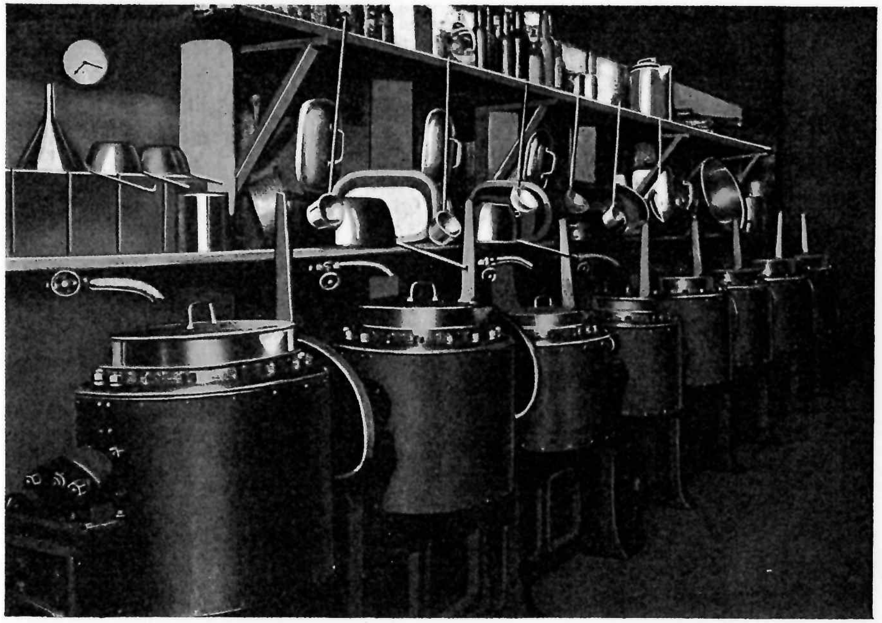
The dangers and disadvantages enumerated are entirely absent from Nickel utensils. Pure Nickel does not oxidise like Iron, Copper, and Aluminium. Harder than these metals, and therefore much more durable, it may, for all intents and purposes, be described as indestructible. Pure Nickel utensils, moreover, when worn beyond possibility of further service, still retain a high metal value, which makes it possible to return the utensils in part payment for new ones. Hence it is not surprising that in recent years very many large up-to-date hotels and ships' kitchens have been equipped with pure Nickel cooking utensils. Furthermore, hospitals, lunatic asylums, barracks, and other establishments which cater for large numbers with strict attention to the precautions of modern hygiene, employ pure Nickel cookers almost exclusively for their kitchen apparatus.

From the ordinary barracks cooker to the manufacture of field kitchen appliances is only a short step.

Owing to the great strain and rough treatment to which military cooking appliances are subjected, they must be made of a material which possesses sufficient strength and durability to withstand even the rough handling inevitable in the field; which is not liable to injury, even if wrongly heated—for instance, when empty or insufficiently filled; which is faultless from a hygienic standpoint, and precludes every possibility of injury to health; which does not require repair in the field, such as would inevitably happen with Copper and Iron, owing to the necessity of re-tinning.

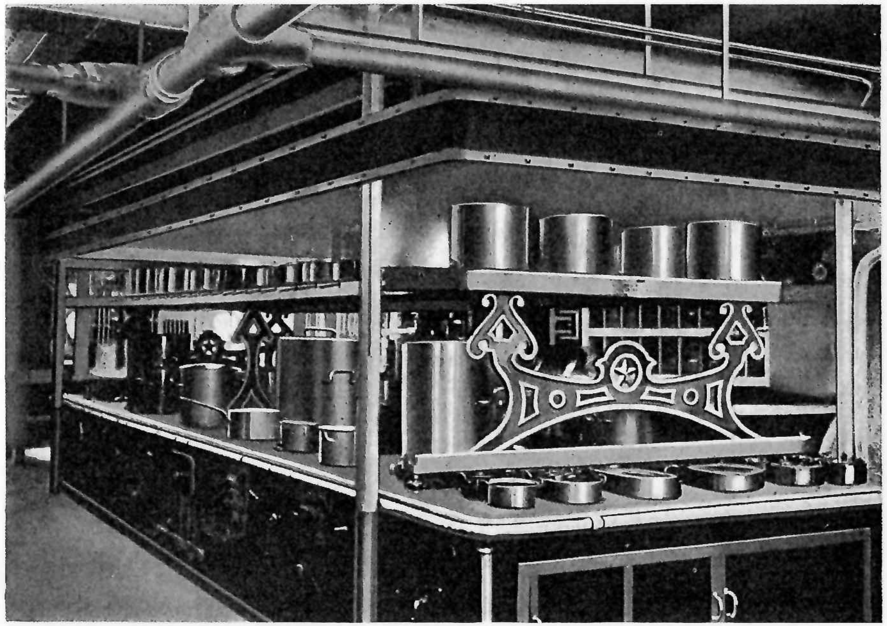
Pure Nickel alone is capable of responding to these varied requirements, and it is to be expected that many countries will soon follow the examples of the Austro-Hungarian and German Governments in introducing pure Nickel field kitchens for the use of their armies, as experiments conducted with Army field-kitchens for some years past, have furnished proof that those sections of troops fed on food prepared in field-kitchens showed a very small proportion of men falling out in comparison with troops not provided with this form of apparatus.

Field-kitchens for military purposes are so designed that food for 250-260 men can be prepared in the course of a few hours, even when troops are on the march.



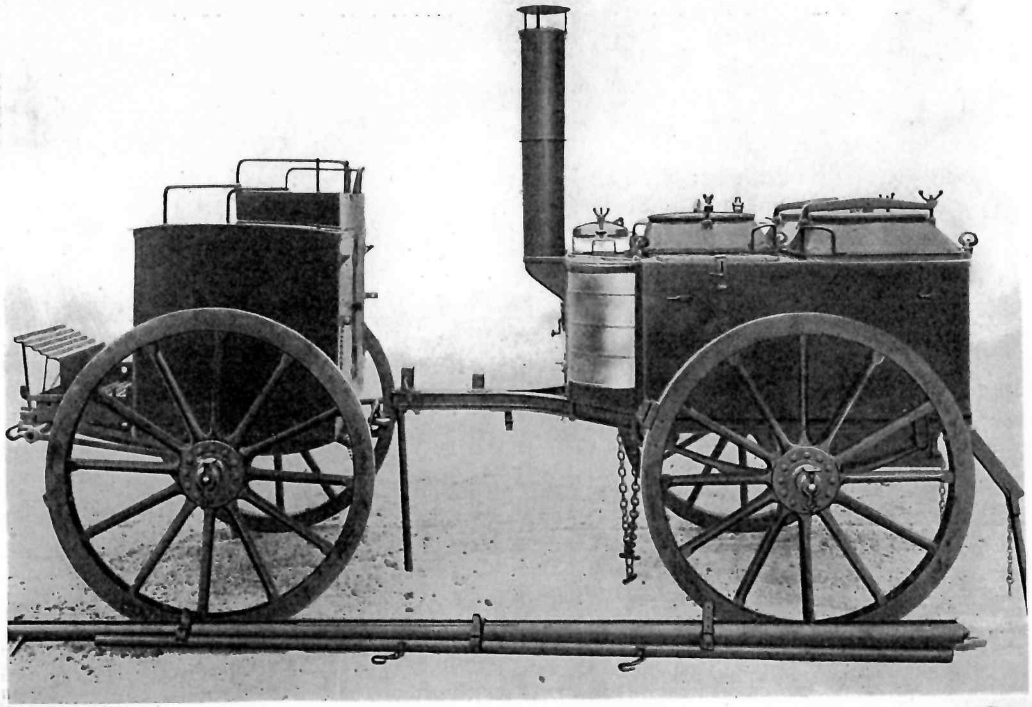
CRANSTON'S TEA ROOMS, LTD., GLASGOW.
NICKEL-LINED STEAM JACKETS.

CURZON HOTEL, LONDON.
NICKEL KITCHEN UTENSILS.

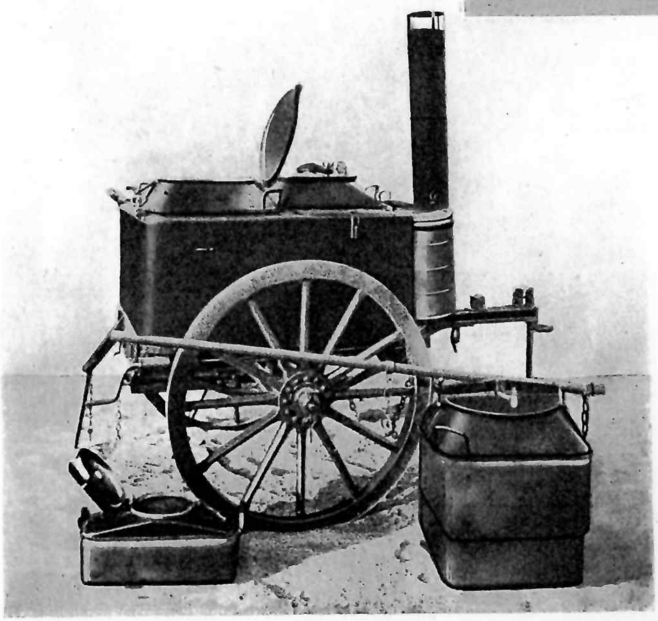


WHITE STAR LINE, SS. "OLYMPIC."
NICKEL KITCHEN UTENSILS.

A highly convenient article for the efficient feeding of troops—especially mountain troops—is the Cooking Chest. This consists of a pure Nickel field-kettle of about 5·72 gallons capacity, together with an Iron under-frame for heating. The kettle and hearth, or under-frame, telescope into each other and are put into a chest made of veneered wood and lined with asbestos straw, oil-paper and cork. The chest is fitted in such a way as fully to retain heat. Some hours before the meal is required, the food is heated to boiling temperature, and the kettle is then put into the chest; the latter is closed and mounted on the saddle, and during transport the food becomes thoroughly cooked. The design of the chest is so ingenious that after 18 hours in an outside temperature of 32° F. the food is still found to have a temperature of 182° F.



ARMY FIELD KITCHEN.
INTERIOR FITTINGS OF PURE NICKEL.



ARMY FIELD KITCHEN.
INTERIOR FITTINGS OF PURE NICKEL.

ARMY COOKING CHEST.
MADE OF PURE NICKEL.

INDUSTRIAL WELFARE

DURING recent years the conscience of the nation has been awakened to the necessity of providing suitable housing accommodation for the workers, to secure not only their physical efficiency but also their mental and moral development. The industrial revolution in the early years of the 19th century increased enormously the wealth of the country, and the wages of industry rose considerably, thus bringing within the reach of the workers the means of obtaining much more of the comforts and amenities of life than they had hitherto been able to secure.

The blessings of the revolution were, however, accompanied by a number of serious social evils. The working classes gravitated towards the factories, which became centres for the aggregation of enormous masses of the population. What before were mere hamlets developed into large towns, ill-arranged, and with little or no pretence to adequate social management. Rapidity of growth, unchecked and unguided, did not, in the nature of things, conduce to what is now a term of art in an Act of Parliament, namely, town-planning. The result is that many of the industrial districts of Britain are monuments of the early neglect of the most elementary consideration for the comfort of the people, in the form of straggling towns and villages, with hideous and insanitary houses, which naturally become fruitful breeding grounds of the worst social evils and of industrial discontent.

It is worthy of note that these circumstances arose in the time of the private employer, who is so much idealised in these days, when it has become fashionable to decry the great Joint Stock

CLYDACH ESTATES.
GENERAL VIEW.

CLYDACH ESTATES.
HOUSES BUILT FOR USE OF EMPLOYEES AND WORKMEN.

CLYDACH ESTATES.
HOUSES BUILT FOR EMPLOYEES AND WORKMEN.

Companies for their supposed lack of interest in the welfare of their employees. The truth is that the employer of the early 19th century hardly ever looked beyond his factory walls. Considerations as to how and where the workers, when brought to the spot, were housed, seldom obtruded themselves upon his mind. Housing schemes did not appear to him to have any bearing on industrial efficiency. Such questions were thought to be within the sole province of the landowner and the speculating builder, whose policy was to build cheaply and sell or rent dearly. And, taken as a whole, a sorry business they have made of it.

Similarly, owners of factories gave little attention to beauty of design or arrangement in the building of their works. The same slap-dash and haphazard methods prevailed. There have been exceptions, of course, which nevertheless prove the rule, and it must be admitted that the standard of factory construction and architecture in Britain is considerably below that which prevails in the two chief competing countries.

Within comparatively recent years, however, there has been a great change for the better. It is only fair to say that the most progressive employers have, as it were, set the pace to Parliament. Factory and housing legislation has made rapid strides, but it can be said with truth that legislation has never advanced beyond what had already become the established practice of the best type of employer. Factory and Housing Acts have never inflicted any hardship on those employers who are alive to their responsibility for the welfare of those whom they employ, and certainly the Mond Nickel Company has, since its inception, adopted a high standard for the accommodation of the workers, both inside and outside their Works.

When it was decided, some years ago, to work the late Dr. Mond's patents for the production of Nickel on a commercial scale, sites had to be selected in Ontario, as near to the Mines as possible, for the initial processes of smelting the ore, and, similarly, in South Wales, for the final operations of refining, in close proximity to the great anthracite coalfield.

CLYDACH ESTATES.
HOUSES BUILT FOR EMPLOYEES AND WORKMEN.

CLUB HOUSE, CLYDACH.
CONCERT HALL.

The firm provide the workmen with admirable clubs and houses to live in; in consequence, they get workmen of high intelligence and efficiency. This is what I call a really beautiful illustration of what can be done by applying high scientific knowledge to industry, and if we had more people of the enterprise of this great firm, this country would not be in the peril it is in at this time with regard to competition after the war from neutral and enemy countries."

The Company may feel proud of this testimony from such a high authority.

THE GROWTH OF CLYDACH

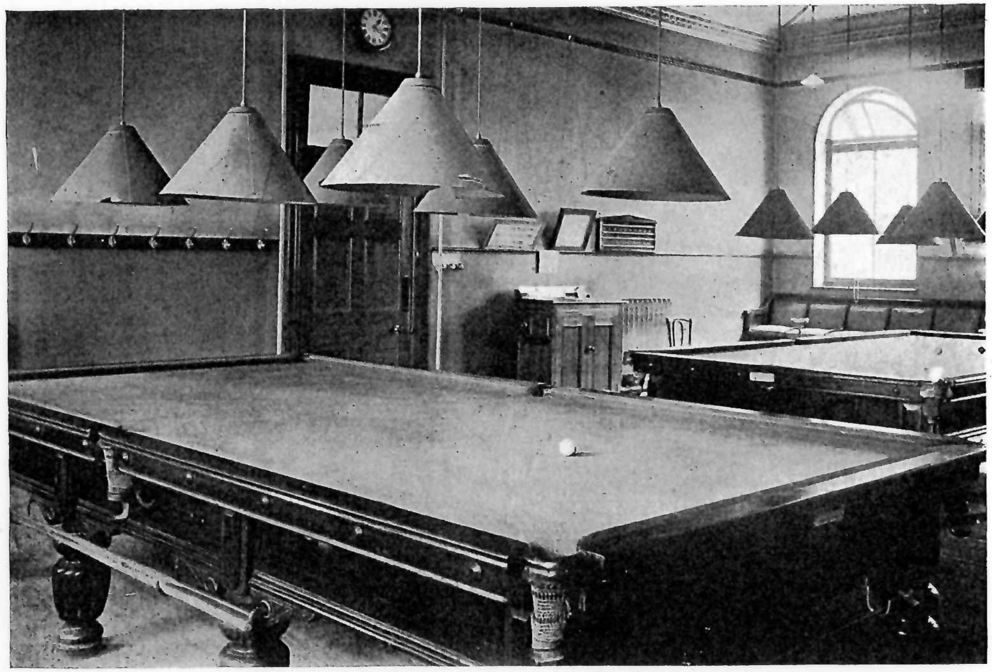
At the time of the starting of the Refining Works, Clydach was a village with a population of about 4,000. The establishment of the Mond Nickel Refining Works has added quite 3,000 to the number of inhabitants.

In view of so great and so rapid an increase, it became necessary for the Directors to consider whether to leave the provision of houses for the additional population in the hands of local builders or, as

The planning of the Works was carried out with great skill and ingenuity under the guidance of scientific experts like the late Dr. Ludwig Mond, and Dr. Langer, with the result that the workers have experienced immunity from serious accidents, poisoning, or other injurious effects upon health.

Lord Haldane, speaking in the House of Lords with regard to his visit to Clydach in 1916 as Chairman of the Royal Commission on Welsh University Education, expressed himself as follows:—

"I had the opportunity of choosing what I would like to see and I chose the new process which is being carried on in Swansea for the production of Nickel in a fashion quite unrivalled by any country in the world. I was shown round by Dr. Langer, who is a remarkable chemist and who was trained, like Dr. Ludwig Mond, at the Chemical School at Zurich. There was a gas chamber, the Nickel being deposited at the other end and all the chemical combination was going on with the utmost precision inside the tubes; deadly as the gas was, not an accident has happened because of the intelligence of the workmen employed.



CLUB HOUSE, CLYDACH.
BILLIARD ROOM.

WORKS BAND, CLYDACH.
BEFORE THE WAR.

SOCIAL ACTIVITIES

The Company have spared no endeavours to further at all times the comfort of their employees. With this end in view a Club House was erected for the use of their workpeople, at an approximate cost of £4,000. The building was formally opened in January, 1909, by Dr. Carl Langer, Managing Director of the Works, who is President of the Institute. That the Institute has justified its existence, is evident from the fact that progress has been reported year after year, until it is to-day recognised as one of the foremost Institutes of its kind in the district.

The social activities of Clydach village centre round its Club. The latter came into being with a membership of about 300, and so greatly has this extended that it now numbers 650. About 250 members of the Club joined the Colours at the outbreak of the war. Some have fallen in the service of their King and Country; popular lads they were; and it is the intention of the Company suitably to perpetuate their memory. On the other hand, it is gratifying to be able to add that the Institute numbers amongst its members two who have won distinction on the field of battle, and have been awarded the Distinguished Conduct Medal.

far as possible, to undertake the matter themselves. They decided upon the latter course, with the object of eventually providing housing accommodation on a liberal scale for all their employees. They fully realised that happy and healthy surroundings for the homes of the workers improve the latter from the standpoint of industrial efficiency. The most beautiful and healthy spot was selected outside the old village, situated on high ground, from 200 ft. to 400 ft. above the sea-level, and overlooking the Vale of Tawe. About 50 acres of land were purchased and plans were prepared for laying out a model village, where, as will be apparent from the accompanying illustrations, comfortable and distinctive accommodation is provided for the workmen and their families.

The number of houses already built and occupied on the Clydach Estate is 170, while 30 others are in course of erection at the present time. In addition to these are 50 more houses in respect of which a contract for construction has been placed, and will be proceeded with as expeditiously as the existing shortage of labour will permit. While 250 houses are thus accounted for, it is estimated that when the building programme has been completed the number of houses on the Clydach Estate will reach a total of between 500 and 600. Moreover, in addition to the foregoing, the Mond Nickel Company own 120 houses in another part of Clydach.

WORKS FOOTBALL TEAM, CLYDACH.
BEFORE THE WAR.

It is difficult to describe in a few words the many activities of the Institute. The taste for indoor amusements is catered for in a variety of ways. In addition to the provision of a Billiard Room with two tables, Air Rifle Range, etc., there are a Library and Reading Room, and Refreshment Room ; while to meet the requirements of the Photographic Section, a Photographic "Dark" Room has been provided. In the Library and Reading Room, in addition to the principal daily newspapers, technical publications and weekly and monthly periodicals, are sections dealing with science, biography, travel, fiction, etc. The Library has proved so useful and popular a feature of the Institute that it has become necessary to publish a catalogue for the use of its numerous members.

Mention should also be made of the Concert Hall, a handsome room, wherein for the first six years of the Club's existence, fortnightly free concerts and lectures were given alternately during each Winter Session. By this means the wives and children of the employees were entertained, and shared in the pleasures of the Institute. To sustain this long sequence of entertainments, a considerable amount of work has devolved upon the various Committees. The programmes have been arranged both by the employees and by their friends in the locality. The Mond Works' Orchestra is credibly reputed to be one of the finest of its kind in South Wales, while the Silver Band has captured several local trophies from time to time.

The foregoing is a very brief synopsis of the indoor activities of the Institute. The Clydach Club, however, is by no means limited by four walls. Its activities extend far beyond the actual Club House for in normal times there was an outdoor aspect of equal interest. Affiliated to the Institute were Football, Hockey, Hurling and Gardening Sections, which, by reason of the war, have temporarily suspended operations to a greater or less degree. A word is also due in regard to the Football Team, which ranked as one of the foremost in the Swansea and District Association Football League, having won the Challenge Cup on several occasions, and the Shield as Champions of the League for one season. The Challenge Cup is still in the possession of the Club. Many pleasant "Saturday afternoons" have been provided by these stalwart footballers. Here it has to be recorded with regret that the Captain elected for the Season 1914-15 fell early in the war, and that others of the "Side" have also fallen, or been wounded. One playing member has been awarded the D.C.M.

The Hockey Section also deserves honourable mention, in that it has provided three players who won their "Trial Caps" in the International tourney.

The Gardening Section, up to the outbreak of war, included a large number of members, and a Flower and Vegetable Show was an important annual event.

From the foregoing brief resume it will be apparent that every employee at the Mond Nickel Company's Refining Works at Clydach is able to find in the varied activities of the Club, suitable opportunities for the gratification of the most diverse tastes.

THE COMPANY'S VILLAGES IN CANADA

THE Company have built a number of villages contiguous to their various mining properties. Of these villages, the most important are Coniston, Levack, Garson, Worthington, Frood Extension, and Mond, comprising a total of 323 houses and cottages, which are distributed as follows:—

Coniston	116	houses.
Levack	95	,,
Garson	39	,,
Worthington	37	,,
Frood	19	,,
Mond	12	,,
Lorne Power Company	5	,,
Total	323	houses.

CONISTON VILLAGE

THE Company has done everything in its power to ensure the comfort of its employees at Coniston, by planning and laying out an entire village for them to live in. The site was good, and much thought was given to the ultimate appearance of the village, with the most satisfactory results. It now comprises a Club House, a Boarding House, and Public Library, eleven houses for the staff and about eighty houses and cottages for the employees, the whole being owned by the Company. Two schools have been erected and presented to the School Board, together with leases of suitable grounds. Churches, Stores, etc., occupy land leased by the Company. Moreover, a considerable number of dwellings have sprung up near this village, providing additional accommodation for the men in the Company's employ.

CONISTON.
CANADIAN PACIFIC RAILWAY STATION.

CONISTON VILLAGE.

General View of the Company's Village, Coniston, Ontario.

CONISTON VILLAGE.
LOOKING NORTH ALONG FIRST AVENUE.

CONISTON VILLAGE.
GENERAL VIEW OF THIRD AVENUE.

CONISTON VILLAGE.
VIEW OF SECOND AVENUE, SHOWING HOUSES OCCUPIED BY FOREMEN.

CONISTON VILLAGE.
GENERAL VIEW OF FOURTH AVENUE.

CONISTON VILLAGE.
MANAGER'S HOUSE.

CONISTON VILLAGE.
ACCOUNTANT'S HOUSE.

CONISTON VILLAGE.
MINE SUPERINTENDENT'S HOUSE.

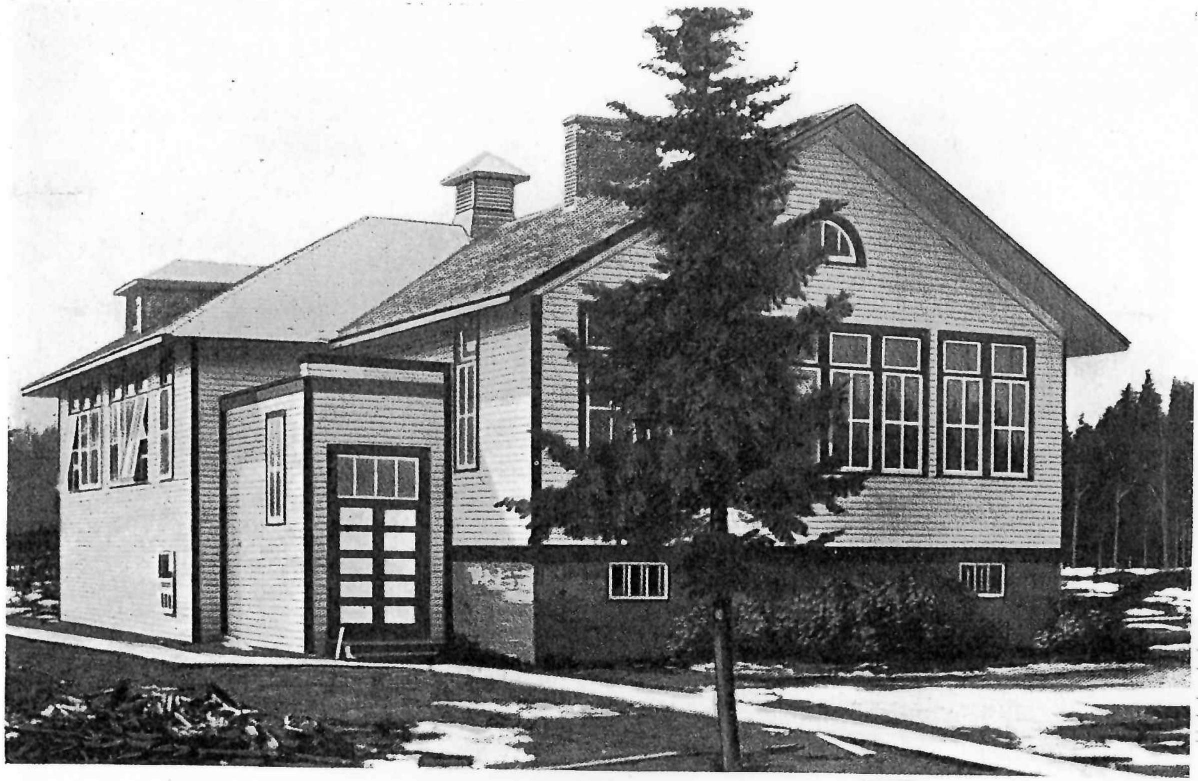
CONISTON VILLAGE.
CHIEF ENGINEER'S HOUSE.

CONISTON VILLAGE.
Typical Cottage occupied by Smelter Employees.

CONISTON VILLAGE.
Crane Operator's Cottage. Winner of First Prize for Garden and Yard Improvements.
The picture shows the general type of Operator's Cottage at Coniston.

CONISTON VILLAGE.
Typical Cottage occupied by Under Officials.

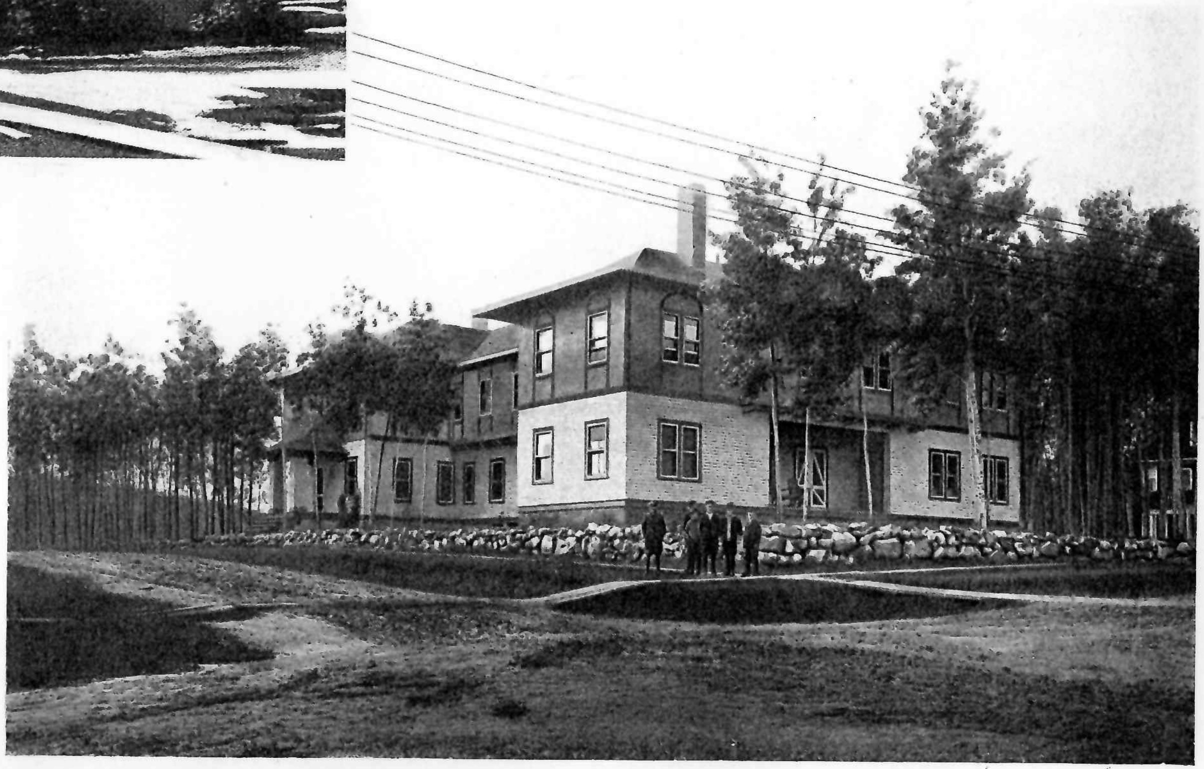
CONISTON VILLAGE.
Switching Engine and Passenger Car en route from Plant to Village at Dinner Hour.



CONISTON VILLAGE

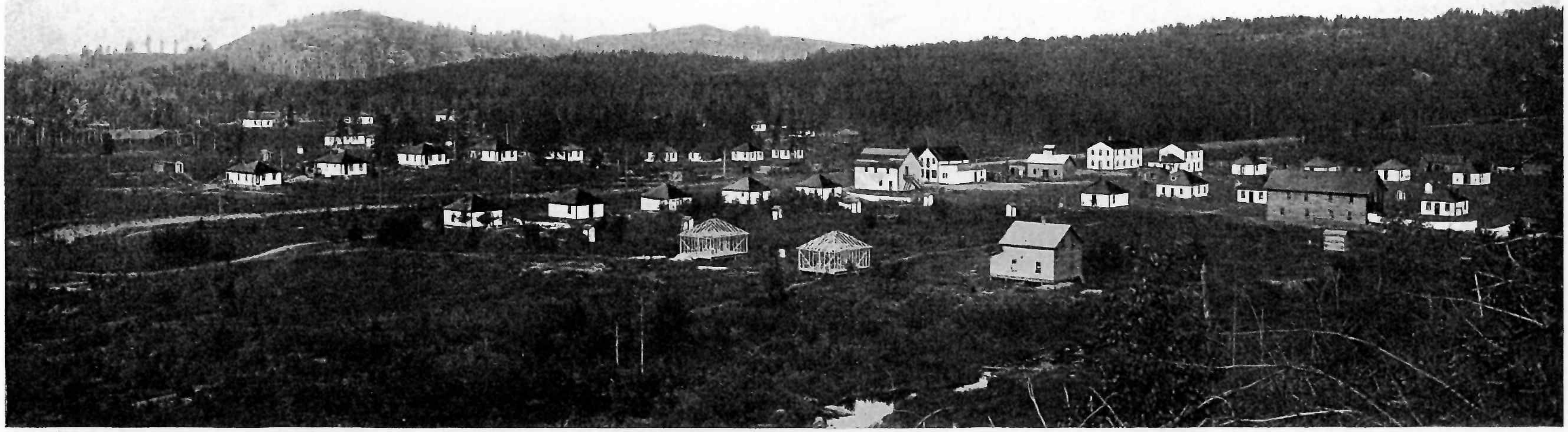
CONISTON VILLAGE.
VIEW OF PUBLIC SCHOOL.

A duplicate building located on Lot alongside of Public School is used for Separate School.



CONISTON VILLAGE.
VIEW OF THE CLUB HOUSE.

WORTHINGTON VILLAGE.
General View of the Company's Village, Worthington Mine, Ontario.



LEVACK VILLAGE.
General View of the Company's Village, Levack Mine, Ontario.