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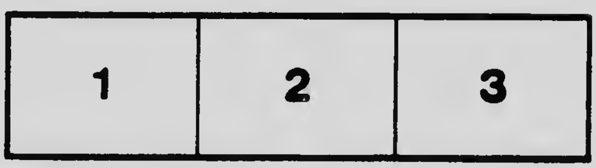
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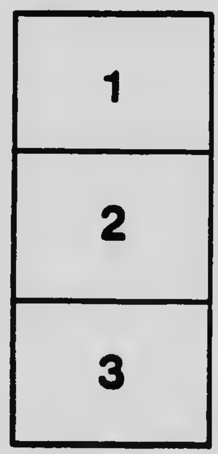
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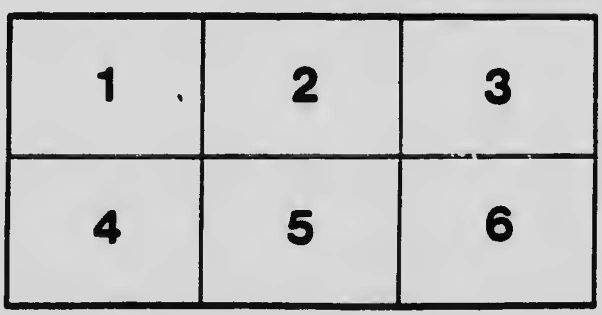
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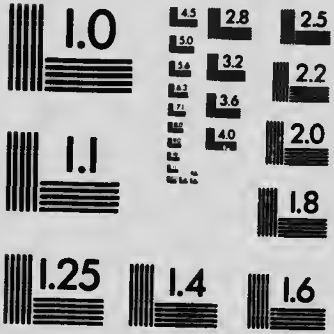

CANADA

DEPARTMENT OF MINES

MINES BRANCH

Hon. W. Templeman, Minister; A. P. Low, LL.D., Deputy Minister;
Eugene Haanel, Ph.D., Director.

REPORT

ON THE

GYPSUM DEPOSITS OF THE MARITIME PROVINCES

BY

WILLIAM F. JENNISON, M.E.

OTTAWA
GOVERNMENT PRINTING BUREAU
1911

No. 84

Frontispiece. PLATE I.

Gypsum quarry at Walton, Hants Co., N.S.

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289—1 No. 84

LETTER OF TRANSMITTAL.

Dr. EUGENE HAANEL,
Director of Mines,
Department of Mines,
Ottawa.

SIR,—According to your instructions, I have completed and herewith submit a monograph on the gypsum deposits of Nova Scotia, New Brunswick, and the Magdalen islands. In this, an attempt has been made to show by descriptions, maps, and photographs, the vast extent of these deposits within this territory; the uses of gypsum, and the processes and cost of manufacturing it into a marketable product.

Although the investigation has been as complete as time and opportunity would allow, still there remains much that is worthy of further investigation. A series of experiments showing tensile and compression tests of gypsum as manufactured into the different products would be productive of much value. The investigation of gypsum as a substitute for marble by the hardening process, which, from the evidence at hand seems to give satisfaction, would open a new market for the products. Some of the associated minerals have much more commercial value than the gypsum itself, but it requires expert investigation to encourage development.

It is hoped that the present work will be useful to those already engaged in the development of this industry, and attract the attention of others to the wonderful, undeveloped natural resources of the country, and encourage them to seek these fields for investment.

I have the honour to be, Sir,
Your obedient servant,

(Signed) W. F. Jennison.

TRURO, N.S., April 12, 1910.

CONTENTS

CHAPTER VIII.

CHAPTER IX.

CHAPTER X.

Appendix I.

Appendix II.

ILLUSTRATIONS.

Photographs.

Drawings.

Maps.

DIRECTOR'S PREFACE.

The text of the following report on the gypsum deposits of the Maritime Provinces of Canada—including the Magdalen islands—is published in the form originally submitted by the author. The original report was accompanied by 3 index maps and 56 detailed sheets. On the latter, an attempt has been made to delineate the boundaries of the gypsiferous areas, and to give other information relating to the various districts. The areas included on these detailed sheets are indicated on the index maps Nos. 64, 65, and 66—each area having a reference number assigned to it. It is not possible to publish the detailed sheets with the report, owing to the expense involved. Of the seventy photographs submitted, it has been possible to reproduce only those which illustrate some special features in connexion with the deposits. Persons who are specially interested in particular areas, can consult the original sheets in the office of the Mines Branch of the Department of Mines; or can obtain tracings of any of the maps, at cost. When copies are required, the map will have to be redrawn before blue prints or other photographic reprints can be made.

The series of maps descriptive of the geology and topography of the Maritime Provinces issued by the Geological Survey Branch of the Department of Mines, give more topographic details than are shown on Mr. Jennison's detailed sheets; but on none of them are shown the approximate boundaries of the areas underlain by gypsum. The boundaries of these maps and their serial numbers are, therefore, shown in blue on the index maps. Copies of the geological and topographical maps published by the Geological Survey can be obtained by applying to the Director of the Geological Survey, Victoria Memorial Museum, Ottawa.

GYPSUM DEPOSITS

OF THE

MARITIME PROVINCES

BY

William F. Jennison, M.E.

INTRODUCTORY.

The study of the gypsum deposits of Nova Scotia and New Brunswick has never been made the subject of an exhaustive inquiry. A number of individual papers have been written on the subject by those who studied them incidentally while engaged in broader fields of geology.

The practically unlimited quantity of this mineral occurring in these Provinces has dimensions which at once arrest the attention of the geologist or traveller; such a variety of forms and colours, often in cliffs from 50 to 150 feet high, affords unusual opportunities to investigate the theoretical and economic problems which present themselves to all interested.

For over 100 years gypsum has been mined in Nova Scotia, yet the industry is only in its infancy. It is a matter of surprise to find how little interest the citizens have taken in the development of this branch of the mining industry. The fact is that this mineral is so common to many of them that they have considered it as of no special value, and a nuisance; yet there is nothing in the mineral industry, here, that offers greater opportunities for the development of a good stable business; and it is important that not only should our own people be informed about our resources, their uses and their values, but that the world should know that in this mineral we have great values and can supply the demand to an almost limitless extent.

The writer has been interested in this study for years, and in July, 1908, received instruction from the Department of Mines at Ottawa, to complete a monograph on the subject. Work began at once and continued throughout the year 1909. During this time eleven months were spent in the field, investigating, examining, and sampling the most important deposits of the two Provinces, as well as the deposits of the Magdalen islands, which were later included in the work.

The field is an interesting one, and although R. R. McLeod in his 'Markland or Nova Scotia,' speaking of the gypsum deposits of Nova Scotia, says: 'Its appearance is so well known and it is so widely scattered through the northern and eastern part of the Province that a catalogue of its exposures would be an endless task and serve no useful purpose'; an attempt will be made to catalogue these deposits, and it is hoped it will serve some useful purpose.

Some profound and interesting questions will be touched upon, but the time alloted for the work, to cover such a large gypsiferous area as it was necessary to do to get the desired information for economic purposes, and the importance of having this publication before the public at an early date, would not admit investigating in detail many of the interesting problems presenting themselves.

The economic importance rather than the theoretical has been the principal object of the writer, and will be dealt with as far as possible in the following pages.

The importance of these gypsum deposits, which have in the greater part been lying dormant for so many years, and which present every variety of colour and composition, can hardly be overestimated. With the increasing demand everywhere for gypsum, and the various products manufactured from it, and with the largest known accessible deposits of great purity, it requires no very vivid imagination to see in them, in the future, one of the greatest natural resources that the country can possess.

In the United States the production of gypsum has increased from 486,235 tons in 1899 to 1,721,829 tons in 1908, over 250 per cent. In Canada, during the same period, the increase in this product has only been 169 per cent.

Comparatively little manufacturing has been done in the Provinces, and for the encouragement of this, maps showing the location of all the deposits of commercial importance, and their proximity to the coal fields, together with plans and specifications of modern plaster mills, will accompany this report. It is hoped that full advantage will be taken of them, and that the economic importance of the deposits will be demonstrated.

Again, as far as known, not a farmer in the Provinces has systematically tried, to any extent, the application of gypsum as a fertilizer. Considerable attention has been given to this question, and it is hoped that in the near future the agriculturist will find it greatly to his advantage to use ground gypsum as a fertilizer, which, without doubt, if used intelligently, on a great portion of the farm lands will give excellent results.

The writer is indebted to many persons for kind assistance rendered in preparation of this monograph.

The officials of the different gypsum companies in the Provinces, and several of the manufacturers and mine operators of the United States, freely gave assistance in collecting data.

Different departments of the geological survey of the United States kindly furnished information and statistics of the gypsum industry. The University Geological Survey of Kansas, Vol. 5, 'Special Report on Gypsum and Gypsum Cement Plaster'; and The Geological Survey of Michigan, Part 2 of Vol. 9, 'The Gypsum of Michigan and the Plaster Industry,' supplied much information.

Various manufacturers of gypsum machinery have assisted with drawings and cuts. Mr. Gibb Maitland, Government Geologist, kindly furnished information from Western Australia. Mr. E. F. Pittman, Under Secretary, gave information from New South Wales, and many others from Great Britain and Europe.

The writer appreciates very much these favours, and wishes to express gratitude to the donors, and the many others that cannot be mentioned.

CHAPTER I.

History and Distribution.

Gypsum has been known and used in various ways from very remote ages. The derivation of the word is not known. Nearly all Greek derivations seem to apply to the manufactured articles, as, γη = earth and εψεω = to cook, or from two Greek words, α = without, and λαμβαι = handles, referring to a perfume box without handles, made from this mineral.

This derivation is said to be inconsistent with the rules of formation of the Greek language. A similar derivation, but said to be more consistent with the Greek rules, gives an origin based on physical character, from α = not, and λαμβανω = to take, so named because it is smooth and slippery and difficult to handle. Both derivations seem somewhat absurd, and it is not likely had anything to do with coining the word. A more possible source is that of a writer who gives an Arabic origin, from *al bastratron*, meaning a white stone, and seems to connect it with the town Alabastron in Egypt, where, in early times, gypsum was found in the mountains near by, and manufactured into ornaments. Θλαβσταης, —has reference to a stone out of which ornamental boxes were made, called alabastra or alabaster stone.

Selenites = (moonstone) of Dioscorides,[1] which he says was called *aphroselenon* = (moon-froth) because it was found at night while the moon was on the increase, was probably crystallized gypsum, the modern selenite. It is sometimes called moonstone, from σελην = moon, and probably refers to the peculiar moon-like white reflections.

About the earliest illustration we have of gypsum in any form is the exterior covering of the pyramid of Cheops which was made from a material almost identical with that of our best cement plaster. This pyramid was built by King Cheops, who reigned, according to Lepsius, in 3095-3032 B.C.

The analysis of this material made by Dr. Wallace, and given in the American Encyclopedia, is as follows:—

	Per cent.
Hydrated calcium sulphate	82·89
Carbonate of lime	9·80
Carbonate of magnesia	0·79
Silica	4·30
Alumina	3·00
Oxide of iron	0·21
	100·99

The writings of Theoprastus, about 33 B.C., show that the Greeks were familiar with its uses, in the calcined condition. The first plaster cast is supposed to have been made by Lysistratus, a brother of Lysippus, the sculptor of

[1] Dana Min., p. 640.

Sicyon, a city in the east of Archia, Greece. It is also recorded that Rhaceas, and Theodris of Samos, made plaster casts after the same method as Lysistratus. Pliny in his works on Natural History, published about the year 77 A.D., tells us that transparent gypsum, called *lapis speculares* (specular stone), probably a compact selenite gypsum, was used to glaze conservatories for preserving fruit trees in winter, and in the construction of beehives to render them transparent; thus enabling the curious to watch the bees at work.

The walls of the temple Fortuna Seia were supposed to be constructed of gypsum, probably of alabaster, and[1] 'the interior though without windows was rendered sufficiently light by the rays transmitted through its semi-pellucid walls.'

The Encyclopedia Perthensis, written in 1816 (less than one hundred years ago), states that, 'there is a church in Florence still illuminated, instead of by panes of glass, by sheets of alabaster near fifteen feet high, each of which forms a simple window through which light is conveyed.'

In Arabia, what is supposed to be an old monastery building of Arsoffa Emii, is constructed of gypsum[2], 'and, when the sun shines on it, the walls give such a lustre that they dazzle the eyes, but the softness of the stone and the redness of the mortar have conspired to make a very ruinous pile at present, though of no great antiquity; the stone having split and mouldered away in the wall, and the foundation has failed in many places.'

In the vicinity of Volterro and Leghorn there is a good quality of alabaster, from which vases and other ornaments were manufactured. In the early centuries lamps were placed in these vases and diffused a soft light over the room.

HISTORY OF OPERATIONS IN NOVA SCOTIA.

In Nova Scotia the gypsum deposits have been known since the early settlement of the Province, but there seems to be no authentic history of operation previous to 1779, and from this date to 1833 there are no records available showing the extent of the business done. The operators, principally farmers, quarried out the rock and hauled it to the point of shipment, in the winter season on sleds, in summer with carts or wagons. Here they would either sell it to local traders, or charter a small vessel and ship it to the United States, the principal market being Lubec, Maine (known at that time as the Lines, meaning the boundary between Canada and the United States.) Where the vessel was chartered, usually the captain was the shipper's broker, and he, on arrival at the mills, would sell the cargo at the best price obtainable, and generally bring back the greater part of the cargo value in flour, oil, and other necessaries.

Following this period, the operations were placed on a better business basis. Men of good business ability gave special attention to producing and exporting this mineral; they made their contracts ahead of their work, with millowners all along the Atlantic seaboard of the United States, and did a prosperous business.

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[1] Ree's Cyclopedia of Arts, Science and Literature, 1814.
[2] Ree's Cyclopedia of Arts, Science and Literature, 1814.

Some attempts were made to manufacture the crude rock, but they were unsuccessful. The home consumption was very limited; the only market was the United States, and as soon as the trade in the manufactured article assumed any importance, this market was closed by a prohibitive duty put on by the United States Government, and the Nova Scotia mills ceased operations. With the exception of a small mill at Windsor, N.S., which for some years has been making selenite cement, for home consumption, manufacturing has been of little importance. During the years from 1861 to 1867 twenty-five ports in Nova Scotia were shipping gypsum, produced from twelve counties. In 1908, six ports in Nova Scotia exported gypsum, from three counties. To-day operations are all carried on by American capital, and with the exception of one or two small concerns the quarries operated are owned by American millowners. The local shipping interest, which a few years ago did practically all the transportation of this product, to-day is practically nil. This work is being done with barges or foreign steamers, and although the volume of business is double that of 20 years ago, about 90 per cent of it is in the hands of one company, who are not content with a supply for their own manufacturing business, but dictate to other mills where they shall purchase their supply of crude rock.

The writer is informed that this has had the result of closing several mills in the New England States, and, therefore, militates against the smaller mills purchasing their supply of crude material direct from the small quarry operator, not because they are getting a better or cheaper rock, but because they fear the competition of the larger operators, with the finished article.

The methods of quarrying and loading have improved somewhat, but not in proportion to other mining industries in the Province. One now sees the hand machine auger, instead of the old pod auger, the fuse instead of the old time squib, the locomotive for long hauls instead of the horse. The year 1909 saw the first steam shovel moving the clay from the top of the quarry; previously the clay covering in this quarry, having a thickness from 20 to 30 feet, was brought down with the gypsum and removed with horses and carts.

The tardiness in this respect is in part due to the fact that the labour used in the quarries is, to a great extent, made up of the sons and grandsons of those who worked in the quarries before them. They are not a roving class, like many miners. They know their work, as they learned it from their forefathers, and it is difficult to get them out of their old ruts; this, however, must be said in favour of these hardy sons of the quarry; no man need dictate to them where or how to put a shot in to get the best results, nor can any wield a breaking pick with more skill and experience than they, and the ease with which they handle the broken rock is little less than marvellous.

The gypsum trade in the past has fluctuated with the conditions of times in the United States, but as will be seen by the statistics in Chapter X, the quantity exported has gradually increased from 52,460 tons in 1883, to 299,045 tons in 1909, but the value per ton has not as good a showing. The average price from 1833 to 1877, in Nova Scotia, was 75 cents per ton. In 1908 fifty thousand tons sold for that price, while about 5,000 tons sold for $1.25 per ton.

Some exceptional prices have been paid for Nova Scotia gypsum, which may, as a matter of history, be worthy of note.

'A[1] few months after the close of the war of 1812, between England and the United States, John DeWolf, of Windsor, N.S., contracted for 3,000 tons of gypsum, at \$9.50 per ton, delivered at Eastport, Maine. Twenty dollars was freely paid at New York, Philadelphia, and southern parts, and it sold readily for from \$3.50 to \$6 per ton, put on board at Windsor, N.S.'

History of Operations in New Brunswick.

In New Brunswick the gypsum industry in early times (previous to 1847) was much the same as that of Nova Scotia.

The principal operations were carried on about 3½ miles in the rear of Hillsborough, Albert county, and the shipping point was on the west side of the Petitcodiac river, about 4 miles from its mouth.

About the year 1847, Messrs. Fowler Brothers, who operated mills at Lubec, acquired rights at Hillsborough, and constructed a plank road from the quarry known as the Fowler quarry to the shipping point. By so doing they were able to operate their quarry, and haul the rock in the summer season on wagons. But it was not until 1854, when Mr. Calvin Tomkins entered the field, that the industry was put on a solid basis. Dr. L. W. Bailey[2] gives the following history of this Company:—

'The superior quality of plaster of Paris made from Hillsborough gypsum, had by this time become well known to other manufacturers of plaster and building materials in the United States, and, about 1854, Mr. Calvin Tomkins, a manufacturer of cement and lime, who carried on an extensive business on the Hudson river, came to Hillsborough and acquired the properties then owned by the Fowler Brothers, and other gypsum properties adjoining, which included nearly all the available and valuable portions of this deposit. At this time the duty upon manufactured plaster entering the United States was very low, and a large market was open for the product of a mill on the Canadian side of the line. These favourable conditions led to the formation, by Mr. Tomkins, of a company under Provincial Act of Incorporation, under the name of the Albert Manufacturing Company, for the purpose of carrying on the business of quarrying and mining gypsum, and erecting mills for the purpose of manufacturing it, carrying on the business of grinding grain, sawing lumber, constructing railways and operating the same, and all other work in connexion with the operation of the quarries and shipment of the product. Subsequently a large milling establishment was erected, railways were built to two or three points in the gypsum belt, and extended to the river, where wharf and timber beds for the accommodation of vessels were also constructed. A plaster mill was also built by Mr. Tomkins at Newark, New Jersey, and the business of making plaster of Paris in Hillsborough, as well as that of shipping the crude rock to Newark, prosecuted with

[1] Dr. How's notes to his Mineralogy of Nova Scotia.
[2] The Mineral Resources of the Province of New Brunswick, p. 86.

energy. Later, the withdrawal of the reciprocal trade relation between the Provinces and the United States occurred, and the favourable conditions under which a large trade in the manufactured article was promised were seriously interfered with, and only a very limited business was obtainable; and had it not been for the very superior quality of the plaster made from Hillsborough rock, profitable business with the United States would not have been possible.'

DISTRIBUTION.

Gypsum is found distributed in many of the countries of the world. The producing countries are given here in order of their importance: France, United States, Canada, Great Britain, Algeria, Germany, India, Cypress, Italy, Switzerland, Sweden, Australia, Tasmania, and Newfoundland.

The following brief description of the occurrence will serve to show how widely this mineral is distributed, both geographically and geologically.

France.—The principal gypsum deposits in France are found at Montmartre, Pantin, Belleville, Sannois, and Enghien-les-Bains. They occur in beds in the Tertiary deposits of the Paris basin, and vary in thickness from a few feet to 160 feet. They are operated both as open-cut quarries, and by sinking shafts, or driving galleries into the hillside.

This country has given to the world the name plaster of Paris, which was originally a French product, now common to the whole world. The rock manufactured is very high in carbonate of lime, often carrying from 10 to 12 per cent, but it is not considered detrimental to its composition, many claiming that the high grade of French plaster is due to the presence of this mineral.

United States.—Gypsum deposits are found in almost every state and territory of the Union. In New York State they are found in regular beds in the Salina or higher formation of the upper Silurian. The greatest thickness is 600 feet, occurring at Fayetteville, and consists of eight layers, from 18″ to 30 feet thick. The largest quarries are at Union Springs. Other deposits in this State occur at Caledonia and Oakfield.

In Ohio, the occurrences of gypsum are somewhat similar to those of New York. They are found in the upper Silurian or lower Helderberg of Orton. Operations are carried on only at one point, near Gypsum Station, Ottawa county. The beds are from 5 to 7 feet thick, and are mined by driving galleries into the hillside about 400 feet.

In Pennsylvania, the gypsum occurs in the lower Helderberg series, but nothing of economic importance is shown.

In Iowa, the deposits are found in the Permian and overlie the Coal Measures. In thickness the beds vary from 10 to 30 feet, and are made up of regularly stratified layers of gypsum separated by thin layers of clay.

In Kansas, the deposits are found in the same geological formation as those of Iowa, and are mined by sinking vertical shafts about 80 feet deep to reach the stratum, which has an average thickness of about 15 feet.

In Arkansas, the gypsum is found in Pike county, in what is known as th Trinity formation. It occurs associated with marls, in great variety of textur and degree of purity.

In Oklahoma, extensive deposits of gypsum occur in the Permian, and forn a part of the largest deposits in the United States; extending, according to Chas N. Gould, from Southern Nebraska across Kansas and Oklahoma into Texas having a length approximately of 600 miles.

The following section given by Gould,[1] will illustrate the character anc thickness of the deposit:—

No.	DESCRIPTION.	Feet.
7.	Massive white gypsum, the Shimer	15
6.	Soft dolomite sandstone	1
5.	Red gypsiferous clay	27
4.	Massive white gypsum, the Medicine Lodge	17
3.	Red gypsiferous clay with green bands of selenite	25
2.	Pinkish, mottled gypsum, irregularly stratified, the Ferguson	4
1.	Red gypsiferous clay with thin green and white selenite bands and layers	86
Total		175

In Texas, besides the Oklahoma beds, deposits occur on the Canadian river, associated with clays; they vary in thickness up to 25 feet.

In Michigan, the gypsum deposits are found in the lower Carboniferous measures. The principal deposits occurring in this State are the Grand Rapids deposit, on the western border of the Lower peninsula, having an area of 10 square miles, and the deposit at Alabaster on the eastern border of Saginaw bay, with an area of about 600 square miles. The first consists of two beds known as the upper and lower beds. The upper is from 6 to 8 feet, and the lower 12 feet thick. They are separated by a thin seam, about 1 foot in thickness, of soft shale, and have a capping of the same material from 12 to 15 feet thick. The whole rests on a hard blue limestone.

Alabaster has the largest gypsum quarry in the State. It has a working face more than quarter of a mile long, with an average height of 23 feet. It carries an overburden from 10 to 12 feet deep of stiff boulder clay, which is removed by steam shovel and tram cars.

In Virginia, the deposits are found in the southwestern part of the State, and, like Michigan, occur in the lower Carboniferous series. The stratum is 30 feet thick and dips at an angle of 50 degrees. It is worked to a depth, on the slope, of 250 feet.

In Colorado, the gypsum occurs in the Jura-Trias formation. The most important deposit shows a face 250 feet long, and 28 feet high at the centre, sloping to 7 feet at the edge.

In Wyoming, there are a number of gypsum deposits of importance. They vary in composition from the pure white compact variety to gypsum earth or gypsite. Geologically they occur in the Red beds of the Triassic formation.

[1] Mineral Resources of Oklahoma, Bulletin No. 1, p. 29.

In California, there are a number of places where gypsum deposits are found in the Tertiary clays, particularly along the coast ranges, in the foothills of the great valley, and in the valleys of Southern California. There are, however, few deposits of economic importance.

In northwestern Nevada, the best known deposits are found in the Humboldt and Virginia Mountain ranges, and probably occur in the Triassic formation. Some deposits in the southern part of the State are supposed to be of the lower Carboniferous age.

In Montana, the gypsum deposits are widely distributed and those of economic importance occur in the lower Carboniferous series. The deposits so far developed are found in Carbon and Cascade counties. The veins vary from a few inches to over 6 feet in thickness, and the gypsum is often pure and free from foreign material.

Gypsum deposits of importance are also reported in Oregon, Utah, New Mexico, and the Black Hills of South Dakota.

Canada.—Gypsum deposits of economic importance are found in most of the provinces and territories of the Dominion of Canada. Those having the greatest area, and most accessible, are found in the eastern provinces, where they occur in the lower Carboniferous formation, and are practically inexhaustible (for particular description see Chapter IV.)

In British Columbia large deposits of gypsum occur, associated with grey schists and white crystalline limestone. They are found north of the middle crossing of the Salmon river, and have a thickness of over 100 feet. They are also found in the vicinity of Spence's Bridge.

In Alberta, on the Slave river, 40 miles above Smiths landing, there is an outcrop of limestone, associated with some gypsum and mineral tar. It is also found one mile south of the forks of Salt river. The exposure is 20 feet thick interbedded, and has underlying it thin layers of red clay.

In Manitoba, at St. Martin lake, 10 miles west of the outlet of Little Saskatchewan river, gypsum deposits are found of considerable importance. The exposures are worked as open quarries, and the product hauled in the winter season to the shores of Lake Manitoba by team; after manufacturing it is shipped by steamer to Westbourne railway station. The rock is exposed on a number of outcrops, the highest being 60 feet above St. Martin lake. Some anhydrite is seen, and large quantities of selenite. Geologically its position is either that of the lower Devonian or upper Silurian, probably the Salina formation.

In Ontario, a small amount of gypsum is mined yearly; it occurs on the Grand river, in the vicinity of Paris, in Brant county. The gypsum formation extends from the Niagara river to Saugeen, a distance of 150 miles. Its occurrence is in veins from 2 to 7 feet thick and separated into several layers.

In Quebec, the principal deposits occur in the lower Carboniferous measures of the Magdalen islands, and will be described in detail in a later chapter.

Great Britain.—In England gypsum deposits of economic importance are found in the following counties: Cumberland, Westmorland, Derby, Nottingham, Stafford, and Sussex. They occur as irregular masses of not very gr extent, the greatest thickness being 15 feet.

The principal deposits are in the counties of Derby, Nottingham, and St ford, and occur in the Trias formation. In Cumberland and Westmorland th have a lower horizon, in the Permian, and in Sussex they occur in the Jurass The rock occurs as a pure white granular and compact, with brown strea coloured by the oxide of iron, and pink nodules.

Germany.—In the Hartz Mountain district of Germany white and greyis white gypsum is found, having associated with it large quantities of anhydrit The deposits are of the Permian period.

India.—Although gypsum is found in small quantities in many of the di tricts of India, no deposits of great commercial importance are known to exis The most extensive deposits are reported as occurring in the Silurian formatio but in the other districts where smaller quantities occur they are associated wit the clays, belonging to the Tertiary age.

Cyprus.—On the east and west coast of the island of Cyprus large and im portant deposits of gypsum occur. The deposits are operated, and the rock i manufactured on the island, and used for building purposes.

Italy.—Deposits of the purest variety of alabaster are found at Val di Mar- molago, near Leghorn, Volterra, Carrara, and other localities. The knowledge o these deposits dates back to remote ages and they are noted in the history o gypsum.

Switzerland.—Greyish-white gypsum is found in deposits of the Triassic formation in Switzerland. The beds have an extensive area, and are supposed to be a deposition from sea water.

Australia.—Mr. A. Gibb Maitland, Government Geologist of Western Aus- tralia, furnishes the writer with the following information, regarding the gypsum deposits of that country:—

'So far as any observations have at present been carried in Western Aus- tralia, the only large workable deposit of gypsum known is the one at Cliffy head, near Dongarra (S. Lat. 29°: E. Long. 115°), but it has never yet been visited by any member of the geological staff, so that our information about it is somewhat meagre.

'It appears that the deposit is in the form of a fine powder,[1] filling the bed of a dry lake to a depth of several feet. The composition of the gypsum as de- termined in the Survey laboratory proved to be:—

Lime, CaO	32·18
Magnesia, MgO	0·39
Soda, Na_2O	0·87
Potash, K_2O	0·13
Iron oxide, Fe_2O_3 } Alumina, Al_2O_3 }	0·11

[1] The crystalline powder is associated with numerous shells of *Cardium unedo* (a living species.)

Sulphuric anhydrite, SO_3	41·75
Carbonic anhydrite, CO_2	2·46
Chlorine, Cl	0·57
Insol. { Silica, SiO_2	1·39
Insol. { Alumina, Al_2O_3	0 35
Combined water, H_2O	16·99
Hygroscopic water, H_2O	[illegible]·84
Organic matter	2·68
	100 71
Less oxygen equivalent of chlorine	0·13
	100·58
Equal to sulphate of lime	70·98
" carbonate of lime	5·27

'Deposits of gypsum have also been recorded from different portions of the State, but not so far as is known in workable quantities.

'In the western division of the State, near Carnarvon, a deposit of gypsum is known; on investigation in the Departmental Laboratory it was found to be made up of:—

	Per cent.
Pure gypsum, $CaSO_4$, $2H_2O$	92·9
Pure calcite, $CaCO_3$	3·8

There is very little doubt that careful search in many of the numerous dry lakes, which occur all over the State, will result in the discovery of other deposits of gypsum of value.'

Mr. Pittman, Under Secretary fo[illegible] Wales, also informs the writer, 'That although numerous specimens o[illegible] have been found, in varying localities, nothing is known of the existence of [illegible] workable deposit within reach of rail. Large deposits are known to exist in the western part of New South Wales, but at great distance from carriage.'

The Mines Report of Victoria shows a production of gypsum for 1908 of 1,730 tons, valued at £1,085.

Newfoundland.—The gypsum deposits of this island occur on the west coast. Geologically they are in the same position and resemble those of Nova Scotia. They occur in extensive beds, with prominent exposures on Romaine brook, at Piccadilly, south side of Port-au-Port bay, and at different points on the south side of St. George bay. The rock is white, and in texture, both compact and granular; very little anhydrite is seen.

CHAPTER II.

Origin of Gypsum.

Numerous theories have been advanced to explain the origin of gypsum, and different theories may, and no doubt do apply to different deposits. It is quite possible that we may have two or more theories well demonstrated even in close proximity to each other. But before attempting to account for the formation of the Nova Scotia and New Brunswick deposits it may be well to give a brief résumé of the different theories advanced.

Hunt's[1] *Chemical Theory of Gypsum Formation.*

Hunt's chemical theory of the formation of gypsum is somewhat complex, but in his opinion this method of origin may be applied to the greater part of our gypsum deposits.

To quote his own words,[2] the theory is as follows:—

(1) 'The action of solutions of bicarbonate of soda upon sea-water separates, in the first place, the whole of the lime in the form of carbonate, and then gives rise to a solution of bicarbonate of magnesia, which, by evaporation, deposits hydrous magnesian carbonate.'

(2) 'The addition of solutions of bicarbonate of lime to sulphate of soda, or sulphate of magnesia, gives rise to bicarbonates of these bases, together with sulphate of lime, which latter may be thrown down by alcohol. By the evaporation of a solution containing bicarbonate of magnesia and sulphate of lime, either with or without sea salt, gypsum and hydrous carbonate of magnesia are successively deposited.'

(3) 'When the hydrous carbonate of magnesia is heated alone, under pressure, it is converted into magnesite; but if carbonate of lime be present, double salt is formed, which is dolomite.'

(4) 'Solutions of bicarbonate of magnesia decompose chloride of calcium, and, when deprived of their excess of carbonic acid by evaporation, even solutions of gypsum, with separation of carbonate of lime.'

(5) 'Dolomites, magnesites, and magnesian marls have their origin in sediments of magnesian carbonate formed by the evaporation of solutions of bicarbonate of magnesia. These solutions have been produced either by the action of bicarbonate of lime upon solutions of sulphate of magnesia, in which case gypsum is a subsidiary product, or by the decomposition of solutions of sulphate or chloride of magnesium by the waters of rivers or springs containing bicarbonate of soda.'

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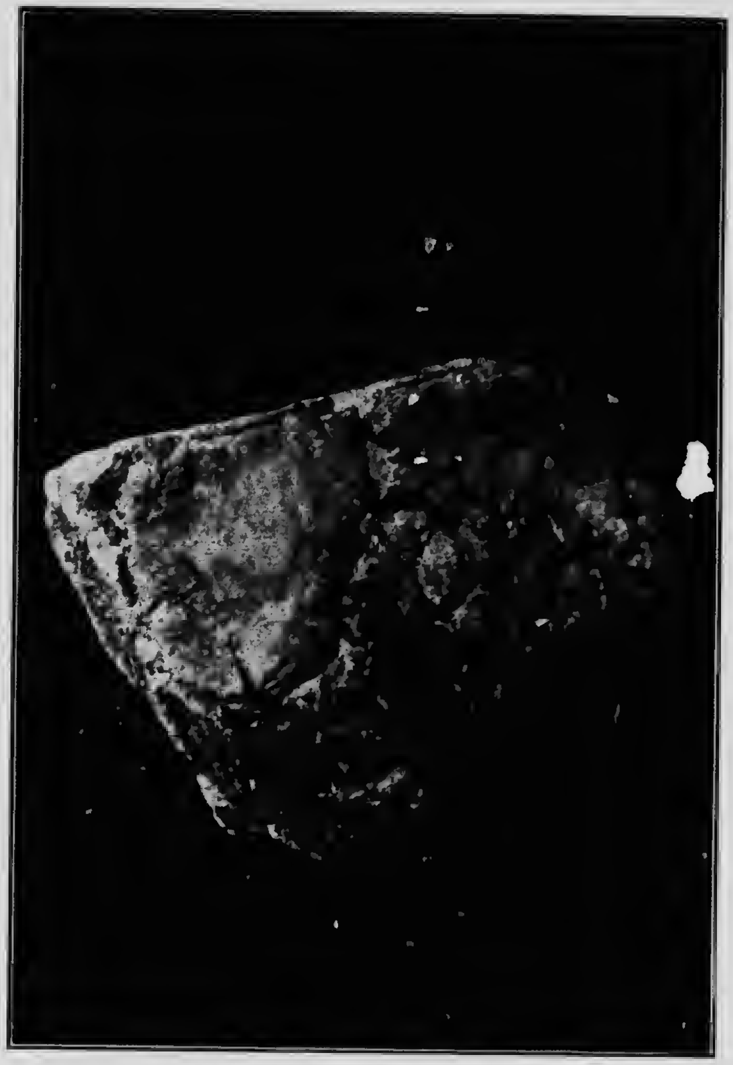
[1] Quarterly Journal Geological Society, Vol. 16, p. 154, 1859.
[2] Michigan Geological Survey Report, Vol. IX, p. 183.



Boulder from Sanderson's quarry, Beaver Brook, N.S., showing conversion of anhydrite to gypsum.

Deposition by Thermal Springs.

Gypsum is deposited by some thermal springs. The sulphurous acid becomes oxidized to sulphuric and converts the carbonates, especially lime and magnesia, into sulphates. Examples of this method of deposition may be found in Iceland, where gypsum is formed by the decomposition of volcanic tufa by acids dissolved in water.

Gypsum Deposited through the Action of Pyrites upon Carbonate of Lime.

Pyrites or sulphide of iron decomposing and coming in contact with the carbonate of lime will change it into a sulphate of lime or gypsum. This action may be seen going on in the Dominion Coal Company's mines at Glace Bay, N.S., where small and almost perfect crystals are often secured. The associated shales, and often the coal itself, in the Nova Scotia mines, are heavily charged ith the sulphide of iron, which carried in solution acts on the limestone, thus producing gypsum.

Gypsum Deposits in Rivers.

Lyell, in his principles of geology (p. 247), cites the La Fiume Salso river, in Sicily, as an example of this method of depositing gypsum.

In many instances, where rivers carry a high percentage of sulphate of lime, they will deposit it at their mouths, or in basins where the current slackens.

Gypsum Formed from Anhydrite.

Anhydrite ($CaSO_4$) on taking up two molecules of water forms gypsum ($CaSO_4\ 2H_2O$). "Extensive beds are sometimes thus altered, in part or throughout, as at Bex, in Switzerland, where by digging down 60 to 100 feet, the unaltered anhydrite may be found. Sometimes specimens of anhydrite are altered between the folia, or over the exterior, also altered to quartz and siderite.'[1]

This action is well illustrated in Plate II, which is a photograph of a boulder taken from Sanderson's quarry at Beaver Brook, N.S. The interior of this boulder is anhydrite, while the surface, showing partings and having a thickness of about 1", is gypsum carrying 20·79 per cent water.

It is also well exemplified, on a larger scale, in the cliffs near Port Bevis, on the Bras d'Or lakes. Here perpendicular walls of anhydrite occur, having a height of from 30 to 50 feet, and over a mile in length, with a top covering from a few inches to a few feet of gypsum. This, without doubt, would have had a very much greater showing of gypsum but for the influence of atmospheric agents to which it has been exposed, and which caused disintegration almost as rapidly as it was formed, leaving in sight only that part which has no economic value, but is of much scientific interest.

In the Cove quarry, at Cheverie, N.S., a bed of anhydrite is shown having a covering of 12 feet of good solid, compact gypsum, which is protected from

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[1] Dana Min., p. 622, Ed. 1889.

erosion by a covering of boulder clay. The gypsum here, although consider by many to be a conversion from anhydrite, shows much contra evidence.

The gypsum of East River, N.S., according to Prof. W. R. Johnson,[1] co tains one atom of water to two of sulphate of lime, ($2CaSO_4 H_2O$) and Da assumes that this compound may have been formed in course of transition; more probably, is a mixture of gypsum and anhydrite.

There are a number of other points in Nova Scotia and New Brunswic where, with a reasonable amount of surety, this method of forming gypsum m be applied; but considering the whole number of deposits as one aggregatio the theory does not seem to be applicable.

If gypsum were formed from anhydrite the action would be continuous whi moisture was available, and the force exerted by the increase (33 per cent of the volume, which, according to Lapparent, is four times that of freezin water, would be in evidence. The hummocky hills, so characteristic of gypsi ferous areas, would owe their origin to this force. But in the area under con sideration it is quite the opposite, and the rounded mounds and hollows, occurr ing generally at the contact between the gypsum and limestone, are caused by depressions, due to erosion by subterranean currents, rather than upheaval. This treacherous ground is constantly giving fresh evidence of this fact.

In June last, in the gypsiferous area of Antigonish county, a part of the main road, about 50 feet in length and 20 feet in width, disappeared to an unknown depth.

Gypsum Deposits from Sea Water.

Sea water, according to the analysis in the Challenger[2] reports, contains 3·5 per cent of mineral salts, of which three-fourths is sodium chloride or common salt. On being analysed these salts show the following proportions:—

	Per cent.
Chloride of sodium	77·758
Chloride of magnesium	10·878
Sulphate of magnesium	4·737
Sulphate of lime (gypsum)	3·600
Sulphate of potassium	2·465
Carbonate of lime	0·345
Bromide of magnesium	0·217
	100 000

When a body of sea water is cut off and evaporated the gypsum is deposited after 37 per cent of the water is removed, and chloride of sodium (common salt) only after 93 per cent has been removed.

The normal order would be a deposit of gypsum, followed by a deposit of salt at least twenty times as great. But as 93 per cent over 2½ times more water must be evaporated before the salt would be thrown down, the evaporation might not go far enough, or if it had, and the sale been deposited, it may have been subsequently removed by solution.

[1] Dana Min., p. 639, Ed. 1889.
[2] Michigan Geological Survey, Vol. 9, part II, p. 186.

In most gypsum deposits (particularly true of Nova Scotia and New Brunswick) the amount of gypsum *in situ* is so large that it is difficult to conceive, at their point of location, an inland sea of reasonable area having sufficient depth to deposit a thickness of gypsum, even equal to that found to-day, not allowing anything for the many years erosion, or loss by glacial action. But, to surmount this possible failure of the theory, it has been assumed, that instead of having a confined body of sea water, we had a sea, having similar conditions to that found in the Mediterranean to-day.

Observations made by Capt. Nares, and Dr. Carpenter, of H.M.S. Sherwater, 1871[1], of the Mediterranean sea, found its basin to be 6,000 feet deep, separated from the ocean by a bar or reef at the Strait of Gibraltar, 1,200 feet high. The water of the Atlantic ocean outside the reef had a specific gravity of 1·026. In the western part of th Mediterranean sea the specific gravity is 1·027, while in the eastern part it is 1·03. The proportion of salt in the Atlantic ocean is 3·6 per cent, and in the Mediterranean it is 3·9 per cent. Passing over the dividing reef are two currents, upper and lower, the upper inflowing, and the lower outflowing.

Under similar conditions, with the temperature of the Carboniferous age, it is possible that sea water flowing into a basin, over a barrier, would evaporate sufficiently to throw down its gypsum, and outflow before sufficient evaporation had taken place to deposit the salt, and the process continue until great thickness would be obtained.

G. P. Grimsley[2] assumed this theory for the deposition of the gypsum deposits of Michigan, and arrived at the following conclusion for the deposits in what he termed 'The Michigan Carboniferous Sea.' The area of rocks in Michigan, formed after the deposition of the Marshall and Kinderhook series, is approximately circular in outline, with a radius of 85 miles, giving an area of 22,686 square miles. As will be shown later, the sea covering this area in Osage time was 700 feet in depth, and assuming the average to be 326 feet, based on well records, there would have been about 1,280,000 billion gallons of water.

'The analysis of the Atlantic Ocean water shows 93·3 grains of gypsum to the gallon. If this Michigan sea had that proportion it would have yielded nine billion tons of gypsum.

'The thickness of gypsum at Grand Rapids is 18 feet, and at Alabaster is 20 feet. The approximate area at Grand Rapids is 24 square miles, and at Alabaster 10 square miles; and while the gypsum does not by any means keep this thickness over these areas, and is even absent in parts of the area, it has probably been removed by solution since its deposition. These conditions would give 1,237,764,000 tons of gypsum.

If the assumption is made that the gypsum covered all the area with a thickness of 20 feet, then it would require 917 billion tons, or 90 times the amount of water in this original sea, and one would need to look for the ridge or barrier

[1] Michigan Geological Survey, Vol. 9, part II, p. 187.
[2] Michigan Geological Survey, Vol. 9, part II, p. 187.

over which the ocean waters flowed to supply the water for the gypsum, un the same was supplied, as in the Great Salt lake, by land drainage.'

Gypsum Converted from Calcareous Matter by the action of Sulphuric Ac

Dana[1] says: 'Gypsum does not constitute layers in the strata, but li embedded masses. The lines of stratification sometimes run through it, and other cases the layers of shale are bulged up around the nodular masses. In such cases, the gypsum was formed after the beds were deposited.' 'Sulph springs often produce sulphuric acid by an oxidation of sulphuretted hydrog 'This sulphuric acid, acting on limestone, drives off its carbonic acid, and mak sulphate of lime, or gypsum.'

Dawson[2], in discussing the different theories and referring particularly the deposits of Nova Scotia and New Brunswick, says: 'I think it is not impr able that there are instances of all or of most of these modes in the gypsifero rocks of Nova Scotia. But for the occurrences of the mineral in so thick a extensive beds, interstratified with marl and limestone, there appears to me to but one satisfactory theory—that of the conversion of submarine beds of ca careous matter into sulphate of lime, by free sulphuric acid poured into the s by springs or streams, issuing from volcanic rocks. Modern volcanoes frequent give forth water containing sulphurous and sulphuric acids.' Water of th kind would have a greater specific gravity than sea water, and, therefore, flo along the bottom of the sea, and if it came in contact with beds of calcareou matter, the above action would take place and the formation of gypsum woul be the result.

Quite in accordance with this view the gypsum deposits of Nova Scotia an New Brunswick are found, without exception, associated with marine limeston In some cases they are so closely associated that it is difficult to draw any lin of demarcation; one graduating with diminishing or increasing prominence int the othe.

In the gypsum deposits at Tom river, Richmond county, N.S., a vein[3] of limestone, about 2 feet wide, may be seen in an exposure of gypsum, 20 to 30 feet high. It cuts it transversely and has very distinct walls. The following analyses will serve to show the composition of both the limestone and the wall rock:—

—	Limestone	Wall rock.
	%	%
Lime	53·13	33·20
Ferric oxide and alumina	0·50	nil
Sulphuric anhydrite	1·36	46·28
Carbonic anhydrite	40·99	nil
Water, loss on ignition	1·02	20·69
Insoluble mineral matter	3·69	0·16
	100·69	100·33

[1] Dana's Manual of Geology, p. 234.

[2] Acadian Geology, p. 262, Ed. 1868.

[3] The term 'vein,' although not technically correct, is used here in preference to the term 'bed,' as it is thought it will better explain this peculiar occurrence of limestone.

In the great gypsiferous belt at Cheticamp, Inverness county, N.S., a distinct belt of limestone, having a thickness averaging about 100 feet, may be seen, vertical, and separating a bed of snow-white massive gypsum from a bed of the greyish-white selenitic variety.

Everywhere, in the gypsiferous field, there is evidence that at one time there existed very extensive deposits of marine limestone. These deposits are often in close contact with what are now our metamorphic hills and mountain ranges. The volcanic action which created these metamorphic hills was not extinct when the marine limestone beds were growing, and no doubt afforded the greater supply of sulphuric acid which converted the limestone into gypsum. If this supply was not sufficient, or if the conversion was not complete before the volcanoes became extinct, it is possible that the supply may have been supplemented from other sources, and the action completed.

The sulphureted hydrogen springs, found in different localities, the iron pyrites, pyrrhotite, chalcopyrite, and arsenopyrite deposits, are all sources of sulphuric acid, and, found in the older rocks in the near vicinity, are quite sufficient to supply the deficiency if it were required. It is, therefore, quite evident that there was, from the many sources, an abundance of sulphur in the field during the Carboniferous age.

There is also, as it appears to the writer, some evidence that has never before been introduced, in favour of the theory of gypsum being a conversion from calcareous material.

In some of the large deposits of Nova Scotia and New Brunswick (particularly the former)—which occur in massive formation, with little disturbance—a number of pipe or blow holes are seen on the top of the deposits, perfectly circular in area, having a diameter from 3 to 6 feet, with perpendicular walls, and often showing a depth of 50 to 60 feet. These occurrences must not be confused with the ordinary sink or kettle holes, with battered sides, so characteristic of gypsiferous formation, but generally occurring in low land, never in the same form or shape as above.

These blow holes have, on certain occasions, been cleaned of the vegetable matter which usually accumulates in the bottom, and been used as a shaft for blasting purposes. This is done by going down near the bottom, driving a small level at right angles, and putting in a large amount of explosive, and tamping the charge by filling up the level and part of the shaft. This operation has been successful in bringing down large heads of gypsum at a remarkably low cost.

It has been suggested by some that these holes have been made by the action of some harder rock, rotated by a torrent of water, thus wearing away the softer material. But they are too numerous, often covering an area of several acres, and so closely are they arranged that it is often difficult to walk between them.

They are best illustrated in the deposits at Walton in Hants county, N.S., but occur in somewhat lesser prominence in many of the other deposits.

There is not the slightest evidence that these are sink or kettle holes, nor does it seem possible for them to be worn by the rotation of harder rocks; and

quite as impossible for them to occur where gypsum is deposited from sea wa
or formed from anhydrite.

The only possible explanation, according to the writer's view, is that t
are vent holes for escaping gases emitted during the conversion of calcare
material into gypsum by the action of sulphuric acid.

ANHYDRITE.

Formula—$CaSO_4$—

	Per cent.
Lime (CaO)	41·2
Sulphur trioxide (SO_3)	58·8
	100·00

H = 3 to 3·5. Sp. G. = 2·8 to 3.

This mineral is known to occur in greater or less quantities, associated wi
almost all the gypsum deposits of Nova Scotia and New Brunswick, sometim
forming separate beds from the gypsum, at other times occurring as large lent
cular masses, completely surrounded by gypsum; sometimes in the centre c
some gypsum deposit, which from superficial examination would appear to b
entirely free from it; but on testing or operating it proves either to be in fron
above, or below, and thus often changes what superficially seemed to be a valuabl
gypsum deposit into a deposit of anhydrite having no commercial value. Ther
is no rule that can be laid down to guide the prospector, or operator, in forming
an opinion regarding the occurrence of this mineral.

The free use of the core drill is the only safe plan to follow, in determining the true value of any gypsum deposit. The ordinary boring machine, by which the operator can determine with exactness when he has struck hard plaster, will not do for testing a depth. More than once, and often at great expense, have operators been deceived by this method of testing. This fact is easily explained; the operator determines, to a great extent, the hardness of the rock by the mechanical pressure required to bore it. In shallow holes he is seldom deceived, but when deep holes are required, necessitating greater length of rods, it requires very extra judgment to determine the difference between the exact mechanical pressure required to do the boring and the pressure acquired by the increased weight of rods, and at the same time make allowance for friction, which in many holes is an important factor. It is quite easy to be deceived under such conditions, especially, as in most cases, no care is given to the borings, they being either wasted, or so mixed together as to be of no value. The opportunities for error with the core drill are not nearly so great, and if intelligently operated, the value of a deposit can be determined with exactness.

The question of the origin of anhydrite is somewhat puzzling. Occurring, as it does, in almost all positions and shapes, sometimes as nodules and lenticular masses embedded in the gypsum, sometimes as beds beneath the gypsum deposit, and often as pinnacles protruding from the top of the deposits and surrounded by gypsum, makes it difficult to apply any particular theory to its formation.

It is a very important question with many of the deposits of Nova Scotia and New Brunswick, whether gypsum was formed from anhydrite, or anhydrite from gypsum.

It has been suggested by Prof. W. O. Crosby that the whole was first deposited as gypsum, and the burial beneath a sufficient mass of superincumbent strata, which would determine the conditions of low temperature, thermo-metamorphism, dehydrated the gypsum and produced anhydrite.

Dr. L. W. Bailey[1], in his studies of gypsum, makes the following references: 'In this connexion it may be observed that Van Hise, in his great monograph on Metamorphism (page 357), says: 'The main source of anhydrite is by the alteration of gypsum,' and again, that 'the chief alteration of anhydrite is to gypsum, with an increase of volume of 60 per cent,' citing as an example the anhydrite deposits of Bex, Switzerland, where the transformation from anhydrite to gypsum has taken place completely to a depth of from 18 to 30 metres, the material below this depth being anhydrite.

On the other hand, there are those who maintain that both gypsum and anhydrite may be deposited from the same solution, the production of the one or the other depending upon the conditions prevailing at the time, these conditions including temperature, depth of water, degree of concentration, and especially the presence of other salts. Thus, Adams observes, 'Anhydrite may be formed from gypsum solutions at various temperatures when these solutions contain other salts in sufficient quantities. For example, it has been found that in the presence of a saturated solution of common salt this change (from gypsum to anhydrite) takes place at 30° C, which is a temperature reached on a summer day.

'This fact satisfactorily accounts for the formation of anhydrite in nature, from concentrated sea water or lake brines.' Van'Hoff, also, in his work on German salt deposits, has made it very probable that the presence of saline matter has a marked influence upon the form in which the lime sulphate is deposited.

Geikie, in his Text Book of Geology, page 115, in alluding to various possible methods of the formation of gypsum, says: 'It may be produced as a chemical precipitate from solution in water, as when sea water is evaporated; also through the hydration of anhydrite;' adding, 'it is in the first of these ways that the thick beds of gypsum associated with rock salt in many geological formations have been formed.'

If gypsum is formed from beds of anhydrite, and these beds show an even strata, then we must expect the interior of our deposits to be of little value, and it would be useless to sink on a floor of anhydrite, hoping to find gypsum below. It may be considered possible that at the time when moisture was being absorbed from the atmosphere, the same action could take place from beneath, as at the point of contact with the older rocks; but in that case, owing to the necessarily

[1] The gypsum deposits of New Brunswick, p. 10.

increased volume, it would create a tremendous force, that, if continued, w not only contort the overlying strata, but cause metamorphism, increase temperature, and prevent hydration.

If anhydrite is formed from gypsum, due to the upheaval of our hills, e ing metamorphic action and dehydrating the gypsum, then, if the action of ing up water began at the point of contact, and the superincumbent struc was not sufficient to cause metamorphism, it is quite possible to have a gyp above and below the anhydrite. This action would probably explain the caus the occurrence of anhydrite in gypsum deposits at Walton, and in the old Pel quarry, at Windsor, where it occurs in lenticular masses, surrounded by gyps passing into one another by insensible gradations.

A very careful study of the different theories, and the great variety of dif ent occurrences of this mineral associated with the gypsum deposits, will sl how difficult it is to make any one theory applicable to all the deposits; but careful study of individual deposits it is probable that the theory applicable each deposit may be determined, and the operators be able to lay out their wo much more advantageously.

GYPSITE OR GYPSUM EARTH.

Although deposits of this mineral are known to exist in the territory und consideration, no attempt has been made to investigate them, and their exte is quite unknown.

Gypsite, or gypsum earth, consists of masses of gypsum grains mixed wi more or less clayey matter and sand. They usually occur in basin-like depre sions, but are sometimes found on rounded hill tops. The theory generally ac vanced for the formation of this mineral is that the ma been deposite by the evaporation of spring waters containing a solutior um which ha been derived from underlying beds, but what seems a mc probable theory that they are formed by the disintegration and erosion of gypsum rock, whicl has been washed down and spread over low lying land in the near vicinity.

Considerable importance is attached to deposits of this nature in the Unitec States, where they are worked and manufactured into different cement plasters

The following analyses by Bailey and his associates will serve to show the general composition:—[1]

—	I	II
	%	%
Silica and insoluble residue	10·67	12·13
Iron and aluminium oxides	0·60	0·99
Calcium oxide	30·20	29·14
Magnesium oxide	0·51	0·42
Sulphuric anhydrite	34·98	37·49
Carbon dioxide (calculated)	5·08	2·03
Water	16·59	16·75
	98·63	98·95

—	III	IV
	%	%
Silica and insoluble residue	10·67	12·13
Iron and aluminium oxides	0·60	0·99
Magnesium carbonate	1·10	0·88
Calcium carbonate	10·21	3·57
Calcium sulphate	59·46	64·63
Water	16·59	18·75
	98·63	100·95

[1] The University Geological Survey of Kansas. Vol. V, p. 149.

CHAPTER III.

Chemistry and Technology of Gypsum.

While gypsum and its uses in many ways were known to the ancients, as h been shown in Chapter I, its real composition was not determined until a mu later date. It will be interesting to go back and recall some of the first inves gations.

In early days it was, on account of some of its peculiar characteristics aft burning, known as a mineral resembling calc-spar, and it was not until Pott, 1764, deseril ed them as two separate and distinct minerals, and stated that sor chemists assumed that the substance artificially produced by the union of su phuric acid with lime was gypsum, and termed it *gypsum artefactum.*

The first experiment along the line of its qualitative composition was ma by Lavoisier, and published in the proceedings of the Acdemie des Science 1765. He decomposed the gypsum by means of carbon, setting free the su phurous vr,pours, which formed a sulphur deposit and proved the presence of su phuric acid. He then, by means of potash, decomposed a solution of gypsum i water and showed the presence of lime. After finding the elements, and to pro the composition of gypsum as determined, he described the following exper ment:—

[1]"I took concentrated sulphuric acid, of which the weight was about doub that of water, and of known purity; I added more water, and then added ca bonate of lime until there was no more effervescence, I thus obtained a selenit which is a true gypsum.' Thus at an early date the qualitative composition gypsum was determined by careful investigation, by one whose name has com down through the annals of history as one of the founders of chemical science.

Later in the history, quantitative analysis was made. One of the firs analyses of gypsum we learn of was made from samples taken from Mon martre, near Paris. This analysis gives:—

	Per cent.
Water	7·10
Sulphate of lime	92·56
Carbonate of lime	0·32
Silica	0·02
	100·00

This analysis indicates ratl.er an anhydrite than a true gypsum, but fron this and other analyses the tl. retical composition of pure gypsum was deter mined.

[1] Academie des Science, 1765. University Geological Survey of Kansas, Vol. 5, p. 8

True gypsum is a hydrous lime sulphate, and when pure has the following chemical formula, $CaSO_4$, $2H_2O$.

This when reduced to percentage will show the following composition:—

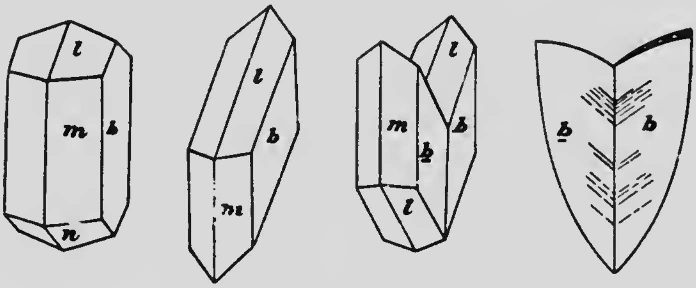
Gypsum ($CaSO_4$, $2H_2O$)	Lime sulphate ($CaSO_4$)	Lime (CaO) ..... 32·6 Sulphur trioxide (SO_3) 46·5	79·1
	Water (H_2O)		20·9
			100·0

When water is absent the mineral is known as anhydrite, which is often found in large quantities, associated with the gypsum of Nova Scotia and New Brunswick, but has no commercial value.

Gypsum is one of the softest minerals; even in the crystalline form it can be scratched with the thumb nail. In the scale of hardness it is 1·5—2, and it has a specific gravity of 2·32.

The crystallization of gypsum is monoclinic; it occurs in the form of plates or prisms with pyramid alternations. Typical forms of gypsum are shown in Fig. 1. The detailed figures 1 and 2 are common crystals, 3 and 4 are twinned crystals.

Fig. 1.



1 2 3 4

Typical forms of gypsum crystals.

Gypsum is slightly soluble in water as shown by the following table:—

SOLUBILITY OF GYPSUM, BY MARIGNAC.[1]

Temperature.	One part Gypsum dissolves in	One part anhydrous lime sulphate dissolves in
At 32° F = 0 C	415 parts of water	525 parts of water.
At 64·5° F = 18° C	386 "	488 "
At 75·2° F = 24° C	378 "	479 "
At 89·6° F = 32° C	371 "	470 "
At 100·4° F = 38° C	368 "	466 "
At 105·8° F = 41° C	370 "	468 "
At 127·4° F = 53° C	375 "	474 "
At 161·6° F = 72° C	391 "	495 "
At 186·8° F = 86° C	417 "	528 "
At 212° F = 100° C	452 "	572 "

[1] Annales des Chimie, Paris, 5th series, Vol. I, pp. 274 to 281, quoted by Chatard, Seventh Annual U. S. Geol. Survey, and verified by Grimsley, University Geological Survey of Kansas, Vol. 5, p. 86.

It will, by the abo, e table, be seen that the point of maximum solubilit be around 38° C, being only one part of gypsum in 368 parts of water. It r be added by way of comparison that 40 parts sodium chloride (common will dissolv in 100 parts water at a temperature of 15.5° C.

CALCINING AND SETTING PLASTER.

If gypsum be heated to a temperature of more than 212° F, and less 400° F, a certain proportion of the water of crystallization is driven off, an partially dehydrated gypsum is known as plaster o. Paris, having the follo formula:—

		Per cent.
$(CaSO_4)2H_2O$	Lime sulphate ($CaSO_4$)	93·8
	Water (H_2O)	6·2
		100·0

Lavoisier, in a masterly analysis of gypsum presented to the Academi Science in 1765, referring to the action of dehydrating gypsum, states, tha heating the gypsum the water was removed at two different stages, and tha first three-quarters is much more easily removed than the balance. Conside the problem of plaster setting, Lavoisier, continuing the description of his ex ments, gives the first discoveries of the set in plaster. Landrin quotes his as lows: [1]"I took the calcined plaster, as has been described before, and w hardens readily with water. I threw it into a considerable amount of wate a pan or large dish. Each molecule of plaster, in passing through the liq seized its molecule of water of crystallization, and fell to the bottom of the in the form of small brilliant needles, visible only with a strong lens. T needles, dried in the free air, or with the aid of a very moderate heat, very soft and silky to the touch. If placed on the stage of a microscope, it is ceived that what was taken under the lens for needles are also parallelopip very fine, so they are described as thicker, many thinner, and many more el gated. The plaster in this state is not capable of uniting with water, but i is calcined anew, these small crystals lose their transparency and their wate crystallization, and become again a true plaster, as perfect as before. One m in this fashion, successfully calcine and recrystallize the plaster even to infin and consequently give it, at will, the property of seizing water.'

Payen confirmed Lavoisier's experiments of the formation of fine crystals the set of plaster, in 1830, and found that at 115° C, gypsum began to lose wa and the loss rapidly increased up to 240° C. In practice Payen considere temperature from 110° to 120° C to be the best, but his experiments also show that gypsum could be dehydrated at a lower temperature—as low as 80° C p viding time enough was allowed.

---

[1] Annales des Chimie 1874, pp. 434, 435. *See* p. 90, University Geological Survey Kansas, Vol. 5

Payen's results[1] are summed up in the following:—

(1) The set of plaster is due to a crystallization of hydrous sulphate of lime.

(2) The lowest temperature at which plaster can be made is 80° C, and the process of manufacturing is very easy.

(3) A temperature of 110° to 120° C is sufficient to deprive plaster of all its water and to cook it completely.

(4) Plaster in small particles favours the drying.

(5) Calcium sulphate heated to about 250° C is dehydrated; at 300° to 400° it loses completely its properties of hydration, or the power of gaining again the water of crystallization, and resembles then the anhydrous sulphate of lime found in nature. If heated higher, it may result in melting the sulphate of lime.

(6) The hardening of plaster by alum is perhaps due to the formation of a double sulphate of potash and lime.

Landrin, whose paper has already been quoted, made an elaborate study of plaster in 1874. He has divided the process of plaster setting into four divisions.[2]

(1) 'The calcined plaster, on contact with water, unites with this liquid and takes a crystalline form.

(2) Tho plaster dissolves partially in water, which becomes saturated with this salt.

(3) A part of the liquor is evaporated, due to the heat set free in the chemical combination. A crystal is formed and determines the crystallization of the entire mass; a phenomenon which is analogous to that which takes place when a piece of sulphate of soda is placed in a saturated solution of this salt.

(4) The maximum hardness is reached when the plaster gains enough water to correspond exactly to the formula SO_3CaO, $2H_2O$, this maximum being to the remainder in proportion to the quantity of water added to the plaster to transform it into mortar.'

'In order to prove the third and fourth principles, Landrin made the following experiments. Taking 23,358 grammes of plaster he mixed it with 10 grammes of water, and he found the weights at different intervals were:—

In 10 minutes	33·100 grammes, or loss of water	0·258	grammes.
In 1 hour and 10 minutes	32·623 " "	0·735	"
In 3 days	29·218 " "	4·140	"
In 10 days	27·290 " "	6·068	"
In 18 days	27·283 " "	6·075	"
After this time no change.			

'The plaster lost in calcining 5·715 grammes, equal to the combined water. In 27·283 grammes of plaster, by formula SO_3CaO, $2H_2O$, there would be 5·710 grammes of water, so that drying ceased when the plaster reached its original composition.'

Chatelier in his theory on the set of plaster disagrees with Landrin in his third principle as given above, maintaining that plaster will set in vacuum and,

[1] Chimie Industrielle, 1830, quoted by Landrin and Grimsley.
[2] University Geological Survey of Kansas, Vol. 5, pp. 87, 90.

therefore, evaporation is not a necessary stop. His theory is, that plaster of dissolves, and becomes hydrated and then crystallized out as gypsum; and particle of plaster goes through these steps.[1]

Professor C. P. Grimsley, who of all modern chemists has probably mad most exhaustive series of experiments, says: "My own experiments agree with those given by Lav· sier, Payen, Landrin, and Chatelier, in that the s plaster is due to the formation of a crystalline network. The cause of the fo tion of this network of crystals, or the factor which starts the crystallizatio the troublesome part to explain, and this has attracted less attention an investigators along these lines.

'When gypsum is burned it forms, as Landrin showed, and as anal prove, the hydrate $(CaSO_4)_2$, H_2O. Marignac called attention to the fact th the water is added in excess, this hydrate in part is dissolved, forming fi clear liquid, which then becomes turbid, and crystals of $CaSO_4$, $2H_2O$, or sum, are thrown down. Now an examination of these formulæ shows that t parts of water have been taken up by the hydrate.

'$(CaSO_4)_2$, $H_2O + 3H_2O = 2(CaSO_4$, $2H_2O)$.

'So first the plaster dissolves in contact with the water, as drin pointed out in his second principle, and as accepted by Chatelier. N some change takes place, whereby, according to Marignac's experiment, the li becomes turbid and crystallization begins. Landrin thought evaporation place as a result of the heat formed by chemical combination, and that the crystal was formed which started the crystallization through the entire m Chatelier showed by experiment that evaporation was not necessary, and argued that by the taking up of this water the solubility of the hydrate decreased, and so, on account of the resulting supersaturation, crystalliza ensued.'

There is little room for doubt but that the set of plaster is due to the for tion of a crystalline network. Plaster partially dissolves when in contact w water; crystallization takes place, whether as Landrin thought, by evaporat due to chemical affinity, or as Chatelier argued, on account of supersaturati the result is the same.

The writer not having the opportunity, nor time, during the present inve gation of the gypsum deposits, to make any series of experiments on the set plaster, has depended largely on the literature already published, and has quo freely from Prof. Grimsley's admirable work on 'The Gypsum of Michigan, well as other authorities on the subject, with the expectation that those enga in, or about to engage in the manufacture of plaster in this country will benefited thereby.

[1] University Geological Survey of Kansas, Vol. 5, p. 91.
[2] Geol. Survey of Michigan, Vol. IX, Part II, p. 138.

CHAPTER IV.

Gypsum Deposits of Nova Scotia.

For many years the gypsum deposits of Nova Scotia, as well as those of New Brunswick, and the Magdalen islands, were considered as belonging to the Permian age. It was not until Lyell, Dawson, and others had made a careful study of the fossils belonging to these measures, that they were placed in their true stratigraphical position, forming part of the lower Carboniferous.

The lower Carboniferous measures of this Province are made up of grey and red sandstones, conglomerates, arenaceous and argillaceous shales, limestones, gypsums, and marls, the various members predominating in different districts, but following no regular order. The following section, as measured by Dr. Gilpin[1] in Pictou county, N.S., is characteristic:—

	Ft.	In.
Red fissile shales	15	0
Compact bluish limestone	4	6
Grey marl with nodules of limestone	21	4
Grey laminated sandstone	6	0
Gypsum with a few layers of arenaceous matter	17	3
Brown marl with veinlets and crystals of gypsum	30	6
Arenaceous limestone, fossiliferous	3	10
Gypsum	8	0
Calcareous fissile sandstone	11	5

The gypsum deposits are not confined to any particular horizon in these measures, but are always found associated with limestone, and marl.

At Cheticamp, Inverness county, they occur near the base of the lower Carboniferous, but farther south in the same county, and on Boularderie island, they occur only a few feet below the Millstone Grit. In Cumberland county they occupy a position about the middle of the series. At the Inverness coal mines, gypsum is found immediately underlying the coal beds, in fact, in one of the slopes of this mine, 1,500 feet from the surface, a block of gypsum was found embedded in the coal seam, but here the whole series has been faulted and cannot be considered a guide to the proper position of the gypsiferous formation.

The best illustration of the irregularity of the occurrence of these deposits will be seen in the lower Carboniferous measures of Hants county, which is one of the largest areas seen in the Province, and has been subjected to less disturbance by faulting or upheavals than any other.

By referring to the index map of Nova Scotia, and sheets Nos. 40, 41, 42, 43, and 45 of the maps accompanying this work, it will be seen that the lower Carboniferous, beginning on the west side of the Avon river and crossing on an eastwardly course its northern boundary, follows the Devonian rocks in a tor-

[1] Gypsum of Nova Scotia, by Edwin Gilpin, F.G.S., 1881.

tuous course to the Shubenacadie river, and continues on an eastwardly co through Colchester county. The southern edge we find has for its boundary g itos, Cambrian slates and quartzites, and Devonian slates. This area has an treme length, as described, of about 60 miles, with an extreme width of 12 m The following rivers running through this area give good opportunities to st sections; the Avon on the west, with its tributaries; the Ste. Croix, Kennete and Cogmagun; the Walton and Tennycape rivers cutting in from the no and the Shubenacadie and its tributary; the Fivemile river, on the east. whole of this area is not considered gypsiferous, but wheresoever the mar limestone occurs there will the gypsum be found. It will be noticed that m of the deposits occur in close conjunction with the contact of these measures the various members of the older series. Not only do they occur at that poi but it will be noticed that on all the rivers, sometimes miles from the conta important deposits are found. The Wentworth gypsum quarries on the Croix river are from 1½ to 2 miles from the nearest point of contact. The Ne port Plaster Mining and Development Company, Limited, has quarries at Av dale, which is five miles from the nearest point of contact.

It will, therefore, be seen that, although gypsum in Nova Scotia and N Brunswick always occurs in the lower Carboniferous measures, and that it always associated with marine limestone as members of the lower Carbonifer group, yet it is not confined to any particular position, and is liable to occur the contact, or at any intermediate point.

ASSOCIATED LIMESTONE.

The limestones of the lower Carboniferous measures are of the marine form ation, and present almost every grade of composition, varying from the high arenaceous and argillaceous to the almost chemically pure. By some writers has been said that many of them ... a high percentage of magnesia. The la Mr. Fletcher, of the Geological ... of Canada, procured two samples fro near the gypsum bed of Judique, Inverness county, which showed 15 and 21 pe cent of magnesia carbonate. The writer's experience of these limestones, wit one exception, is that where immediately associated with the gypsum they a particularly free from magnesia. The exception is the recent analysis of sample taken from the limestone belt dividing the gypsum beds of Cheticamp (see analy ses, page 44) which shows 16·83 per cent magnesia. From over fifty of thes deposits in different parts of the Province, examined by him, samples by analysi showed less than 2 per cent carbonate of magnesia. This, however, is not tru where the limestones are immediately associated with the manganese deposits which are oftentimes in close proximity to the gypsum.

The limestone associated with the manganese deposits in Pictou county showed as high as 10·15 per cent carbonate of magnesia, while those of Col chester gave 28·03 per cent, and at Tennycape, Hants county, some show as high as 35·44 per cent of magnesia carbonate.

Plate III.

Transparent crystal of selenite.

PLATE IV.

Fibrous selenite crystals.

PLATE V.

Gypsum with embedded selenite crystals.

289—p. 40.

It seems probable that, as the manganese often occurs within a few hundred feet of the gypsum, the samples furnished by Mr. Fletcher may possibly have been associated with manganese, rather than gypsum. The gypsum, particularly in Cape Breton island, is very free from this element, with the exception of those samples which were taken nearest the limestone belt above referred to, which showed small quantities of magnesia. (See analyses page 44). In over fifty samples taken from different parts of the island, only one showed even a trace of magnesia.

DESCRIPTION OF DEPOSITS.

The deposits present much variety of colour and texture. The greater part in texture may be classed as compact or crypto-crystalline, with lesser quantities of granular or saccharoidal. In some places considerable quantities of selenite occur, showing folia, sometimes a foot or more across and transparent throughout, as shown in Plate III; and the fibrous varieties are seen in many places associated with the gypsum and marls, Plate IV. Crystals of selenite are often found disseminated irregularly through the gypsum beds. A characteristic example of this is shown in Plate V, usually in groups or bunches, sometimes in veins of importance.

Anhydrite often occurs in extremely variable proportions in many of the deposits, with great irregularity, and the occurrence of this mineral, which is practically valueless, with the gypsum, often interferes with the economic operation of the quarries.

The following brief description of the gypsum deposits of Nova Scotia, with analyses furnished by Mr. F. G. Wait, chemist for the Mines Branch of the Department of Mines, is intended to give essentially the conditions of most economic importance, rather than to deal at length with the geological conditions of each deposit, which are very similar and have been referred to in the foregoing pages.

For convenience of description and future reference, the following table will show the division of Nova Scotia into gypsum districts, the counties included in each district, and the map sheets named for the locality to which they apply, and numbered for reference to the index map:—

TABLE, GYPSUM DISTRICTS OF NOVA SCOTIA.

Gypsum District.	Counties.	Number and Name of Map Sheet.
A	Inverness and Victoria.	1, Pleasant bay. 2, Aspy bay. 3, Ingonish. 4, Chetica 5, Margaree. 6, N. E. Margaree. 7, Broad Cove ma 8, S. E. Margaree. 9, Ross section. 10, Inverness. 11, Mal 12, Smith island. 13, Middle Bridge. 14, Denys ri 15, Malagawatchkt. 16, McKinnon harbour. 17, Nyan 18, Port Bevis. 19, Island Point. 20, St. Ann. 21, Saund cove. 22, East bay. 23, Tom river. 24, Black ri 25, Madame island. 26, Askilton.
B	Guysborough and Antigonish.	25, Madame island. 26, Askilton. 27, Tracadie. 28, Pomq harbour. 29, Antigonish harbour.
D	Pictou, Halifax, and Colchester.	30, Westville. 31, Bridgeville. 38, East Mountain. 39, Sho lake. 40, Shubenacadie river. 48, Elmsdale. 49, Gay riv 50, Musquodoboit. 51, Stewiacke river. 52, Newton mills.
E	Hants.	39, Shorts lake. 40, Shubenacadie river. 41, South Maitlan 42, Noel. 43, Walton. 44, Cheverie. 45, Avon riv 46, Clarksville. 47, Ninemile river. 48, Elmsdale. 49, Gay riv
F	Cumberland.	32, Malagash. 33, Pugwash. 34, Philip 35, Springh mines. 36, Nappan. 37, Parrsboro.

Sheet No. 1, Pleasant bay, Inverness county.

Here a small gypsiferous area occurs, but it and a small area at St. La rence bay in Victoria county, which also has outcrops of some importance, a owing to their situations on the exposed coast of the Gulf of St. Lawrenc without harbours, and, therefore, practically inaccessible, and may be conside at present of no commercial value, except for local purposes.

Sheet No. 2, Aspy bay, Victoria county.

Extending from the Atlantic ocean, inland about six miles, in a somewha triangular shape, occurs one of the most important gypsiferous areas on th island of Cape Breton. Its occurrence, comprising nearly 8 square miles, is i comparatively low lands surrounded by hills of the older Pre-Cambrian rock often 1,000 feet in height, and it is practically all undt lain with gypsum.

Two rivers, the North Aspy river and the Middle river, run through thi area, exposing cliffs having a height from 40 to 70 feet, and their meadows mak a very easy gradient from the deposit to the sea.

PLATE VI

Gypsum exposures at Aspy bay, C.B.

289—p. 42.

PLATE VII.

Gypsum exposures at Ingonish harbour, C.B.

The exposures are extensive as will be seen by Plate VI. The rock is white, and mottled white and grey, compact crystallization showing some little anhydrite, which carries petroleum in small (pea size) cells at the base of exposure.

The following analyses, from average samples taken from the exposures, will serve to show the composition of the rock:—

—	I	II	III
	%	%	%
Lime	41 30	33·62	32·97
Sulphuric anhydride	57·91	45·28	46 16
Water, loss on ignition	0·82	21·06	21·00
Insoluble mineral matter	0 07	0·05	0·15
Bitume	0·08	....	....
	100·08	100 01	100·28

No. I. Anhydrite showing cells of crude petroleum.
No. II. Sample from the McPherson property.
No. III. Sample from the McLeod property.

At present the deposits are inaccessible for want of a harbour. The natural outport would be North pond, at Dingwall. This pond, which has sufficient depth of water for shipping purposes, has been separated from the ocean by the washing of sand and gravel up from the ocean bed, forming a narrow bar across the entrance, and thus closing to navigators one of the best harbours on the coast.

Sheet No. 3, Ingonish, Victoria county.

On the north side of Ingonish harbour a small area of 2,871 acres occurs, and although this area is small, the quality and quantity of the gypsum, together with the accessibility of the deposit, gives it commercial importance. The greatest exposures, from 30 to 70 feet in height, are shown in Plate VII, and occur at the water's edge on the north side of the harbour, where a ship might easily moor to the rock and have sufficient depth of water for loading purposes. The entrance to the harbour is somewhat silted up, and at present will not give sufficient depth of water for modern transportation.

The gypsum is a pure white compact variety, free from any exposures of anhydrite, or other detrimental substances.

Analysis:—	Per cent.
Lime	33·12
Sulphuric anhydride	45·88
Water, loss on ignition	21·10
Insoluble mineral matter	0·22
	100·32

Sheet No. 4, Cheticamp, Inverness county.

On this sheet will be seen a gypsiferous belt, skirting the metamorphic hills from the mouth of the Cheticamp river on the north to well below Friar point on the south, a distance of over 13 miles, and at no place a gre^ter dist than 2 miles from the sea coast. Its width varies from about 600 feet to 2,500 feet.

The principal outcrops occur on the southeast side of Aucoin or Mill b about 3 miles from the northern extremity, and at Grand Etang harbour, a the same distance from the southern extremity.

Between these two points, and their extensions both north and south, gypsum is mostly concealed, but is traceable by the characteristic sink l and hummocky ground, under an overburden of clay.

The northern exposures, shown in Plates VIII and IX, on the east sid Aucoin brook, are composed of a series of precipitous cliffs, from 60 to feet high, above the level of the brook, and forming a narrow plateau par to and at no great distance from the base of the great plateau of northern C Breton.

The southern exposure occurs near the head of Grand Etang harbour, w the high cliffs of white compact gypsum outcrop near the water's edge.

The northern exposures have been developed by the Great Northern Mi Company, who have established a plaster mill near the face of the By referring to Fig. 2, which is an ideal section across the meas at this point, it will be seen that this area alone contains very exter deposits of gypsum, made up of different beds interstratified with limest The first or lower bed, overlying the metamorphic series, consists of a com variety of snow-white and white gypsum; resting on this is a bed of carb ferous limestone having an average thickness of about 100 feet; above the l stone is a very extensive bed of grey and white selenitic gypsum. The va of the Mill brook is all underlain with gypsum, and covered with from a inches to a few feet of red clay; on the western side the gypsum again crops with considerable prominence.

[illegible]e high bluff of selenitic grey and white gypsum is often cut by vert v[illegible] [illegible] pure transparent selenite, running parallel to the strike, with vein [illegible] [illegible]ringers cutting off horizontally. One of these veins has a width from 20 feet, and may be traced for at least half a mile.

The following analyses will show the results of average samples caref taken from different parts of this property:—

—	I	II	III	IV	V	VI	VII	VIII	
Lime	32·17	32·10	32·11	33·42	32·23	32·36	32·96	32·80	2
Magnesia	0·08	0·40	0·23	tr.	......	tr.	......	.....	1
Ferric oxide and alumina	0·18	0·24	0·42	0·20	0·18	0·14	......	......	
Sulphuric anhydride	46·07	45·74	45·88	46·51	45·91	45·80	46·20	46·32	
Carbonic anhydride	......	......	......	......	tr.	......	.....	.....	4
Water, loss on ignition	20·75	20·03	20·52	20·70	20·66	20·75	20·98	20·92	
Insoluble mineral matter	0·16	0·46	0·26	0·26	0·86	0·38	......	......	1
	99·41	98·97	99·42	100·09	99·78	99·43	100·14	100·04	1(

PLATE VIII.

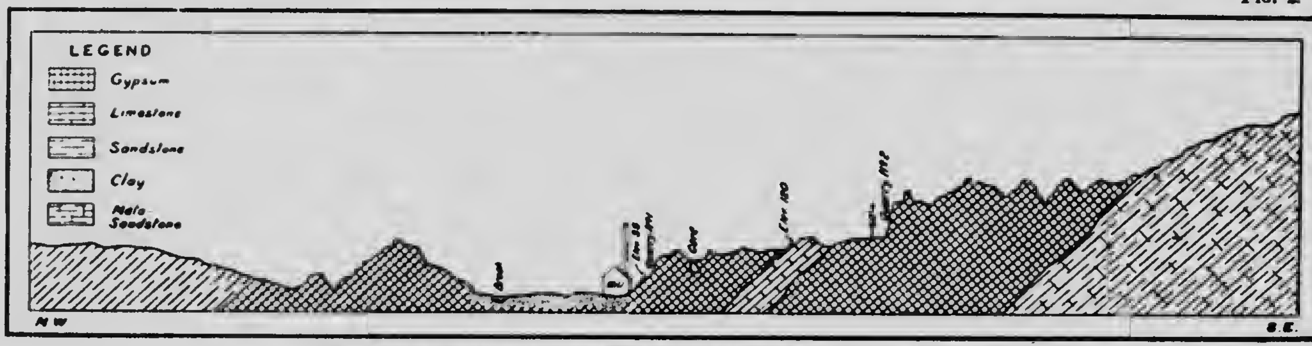
Gypsum exposures at Aucoin brook, C.B.

289—p. 44.

PLATE IX.

Gypsum exposures and works of Great Northern Mining Company at Aucoin brook, C.B.

Fig. 2.



Section through Great Northern Mining Company's gypsum deposit, Cheticamp, N.S.

No. I. General average from No. 1 quarry.
No. II. Sample from the cave, greyish white rock.
No. III. General average from No. 3 quarry.
No. IV. Sample of the selenite rear of mill.
No. V. Sample of the selenite northwest of mill.
No. VI. Sample from adjoining property.
No. VII. General sample white rock from No. 2 quarry.
No. VIII. Sample from 8 ft. selenite vein.
No. IX. Sample from the limestone vein running through the property.

Sheet No. 5, Margaree, Inverness county.

In the valley of the Margaree river occur several unimportant gypsiferous areas, which will be known as No. 5, Margaree, 1·41 square miles; No. 6, Northeast Margaree, 8·60 square miles; No. 8, Southwest Margaree, 3·55 square miles; and No. 9, Ross section, 1·6 square miles.

In the Margaree area all the gypsum is concealed by an overburden of clay, except a small outcrop on the shore near the mouth of the river. The above is also true of Southwest Margaree, small outcrops occurring on Allen brook and Upper Margaree.

In the Northeast Margaree area, outcrops occur at Levis farm, Hogsback hill, and on the west side of the river. The most important of these is that at Hogsback hill, where a good white compact gypsum outcrops in considerable prominence, and at Munroe brook, where the gypsum forms a cliff 75 feet high, and the brook flows through it, to the Margaree river.

In the Ross section the principal outcrop occurs on the west side of Northeast Margaree river, near where the Munroe brook disappears in the gypsum cave.

Although much of this is of very good quality, yet it is not at all probable it will become of great commercial value, being inaccessible to transportation facilities. It should have some value for local purposes, such as a fertilizer, as the soil of the Margaree valley is particularly adapted for its use, and it would give excellent results on clover and leguminous crops.

The following are analyses taken from this territory:—

—	I	II	III	IV	V
	%	%	%	%	%
Lime	33·20	33·00	30·80	32·80	33·20
Ferric oxide and alumina	....	....	0·66	0·30	....
Sulphuric anhydride	44·68	45·64	40·60	45·72	46·32
Carbonic anhydride	....	....	1·85	....	....
Water, loss on ignition	21·04	20·96	19·80	20·62	20·92
Insoluble mineral matter	0·30	0·30	5·61	0·80	....
	99·22	99·90	99·49	100·24	100·44

No. I. Sample from Levis' farm, Hogsback hill, Northwest Margaree.
No. II. Sample from north side of Margaree river, Munroe brook.
No. III. Sample from Grier farm, Northwest Margaree.
No. IV. Sample from Grier farm, Northwest Margaree.
No. V. Sample from Grier farm, Northwest Margaree.

Sheet No. 7, Broad Cove marsh, Inverness county.

In this section occur three small gypsiferous areas. The most prominent is on the sea shore about a quarter of a mile north of the mouth of McLeod brook, and although narrow it extends northwardly nearly 2 miles. This, together with the other two lying between the road leading to Southwest Margaree and the road to Inverness, make up a total area of 214 acres. These are also, at present, unimportant for commercial enterprise, being inaccessible to shipping facilities.

Analyses :—	Per cent.
Lime	32·80
Ferric oxide	.....
Sulphuric anhydride	46·20
Water, loss on ignition	20·92
Insoluble mineral matter	.....
	99·92

Sheet No. 10, Inverness, Inverness county.

Here, having the advantage of the Inverness and Richmond railway, and its probable extension, and their close proximity to the coal mines, the deposits again become more important. At Broad Cove chapel, the outcroppings at the sea shore are extensive cliffs, consisting in the greater part, of a white compact variety, with some little grey associated, and limestone encased in gypsum, as described in a previous chapter, is seen. This deposit has an area of 84 acres.

In the rear of this, about three-quarters of a mile back from the shore and extending inland nearly to Loch Ban, is another area of 488 acres. This has practically no outcrops, being covered almost entirely with a heavy overburden of clay.

Two and one-half miles from the town of Inverness the third area in the section occurs, containing 614 acres.

In this some very prominent outcrops can be seen. Just below the big trestle, at a point known as the Laurie quarry, the outcrop has a height of 45 feet above drainage level. The rock is a white compact variety, mixed with a dark grey shaly variety having rusty stains. Above this about one mile, on the McIsaac lot, an outcrop shows more even texture and colour, principally white and compact.

The following are analyses of samples from this section:—

—	I	II	III
	%	%	%
Lime	33 00	32·20	33·
Ferric oxide and alumina	....	·20	....
Sulphuric anhydride	46·56	46·00	46·
Water, loss on ignition	20·90	20·60	20
Insoluble mineral matter	....	·90	. ... .
	100·46	99·90	100·

No. I. White compact from Laurie quarry.

No. II. Dark grey shale from Laurie quarry.

No. III. White compact, McIsaac lot.

Sheet No. 11, Mabou, Inverness county.

In this section there are numerous gypsiferous areas which are more or l available for commercial purposes. They comprise a total area of 6·55 squ miles.

At Finlay point, on the sea coast, and about one mile north of Mabou c mines, occur cliffs of excellent white compact gypsum from 35 to 50 feet height. This area extends along and borders the sea coast for nearly miles. The exposures here are large, and every indication points to an tensive deposit of gypsum of a quality suitable for all ordinary manufactur purposes, but the sea coast is rugged, and very little protection could be given shipping. To operate this deposit it would, therefore, be necessary to make shipping point at Mabou harbour, a distance of 3½ miles over a rather diffic pass.

At Mabou harbour the most important deposits are located, and known the Col. Snow property, and the Beaton property.

The rock is exposed in cliffs from 45 to 60 feet high, and consists alm wholly of a white compact gypsum, with smaller quantities showing microsco crystals of selenite. Small quantities of anhydrite may be seen at the base the cliffs.

Following east to Hillsborough, and south to Southwest Mabou, large gy ferous areas occur, but consist in the greater part of concealed measures. La outcrops of a very soft, grey, and dark grey, granular gypsum, suitable only land plaster, occur at Hillsborough. At Southwest Mabou the rock is similar texture, and has associated with it fine crystals of selenite.

The following analyses of samples from these different deposits will show the composition:—

—	I	II	III	IV	V	VI
	%	%	%	%	%	%
Lime	32·80	32·80	33·88	32·92	33·40	33·00
Sulphuric anhydride	45·90	46·20	44·36	46·24	46·28	45·61
Water, loss on ignition	20·85	20·85	20·87	20·87	20·45	21·20
Magnesia	....	....	....	....	trace.	....
Insoluble mineral matter	0·40	0·30	0·50	....	....	....
	99·95	100·15	99·61	100·03	100·13	99·81

No. I. Sample from Hillsborough, light grey, with heavy red incrustation.

No. II. Sample from Hillsborough, dark grey, soft granular.

No. III. Sample from Beaton property, white compact variety.

No. IV. Sample from Col. Snow property, white compact, with crystals of selenite.

No. V. Sample from Finlay point, white compact, and free from selenite.

No. VI. Sample from Southwest Mabou, very soft, granular, with selenite crystals.

Sheet No. 12, Smith island, Inverness county.

On this sheet occur three small gypsiferous areas consisting of 212·8 acres. The largest and most important of these is that of 148·8 acres, on Smith island.

This island is situated about one mile from the mainland, and opposite Port Hood. Its topography is low, and the exposures, which in the greater part are on the exposed side of this island, appear as extensive beds associated with shales and carbonate of lime, and may be traced from shore to shore by broken land and pits or sink holes.

The gypsum occurs in alternating layers with the carbonate of lime and marls, the latter carrying extensive quantities of fibrous gypsum.

At Ragged point, and at Cape Susan, at one time, was an area of considerable importance, which has been, by erosion of the sea, divided into two, having a total area of 64 acres. The occurrence here, like Smith island, has few outcrops, and the gypsum and limestone are closely associated. Large quantities of marl are also prominent.

The close proximity of these areas to the railway and coal fields makes them desirable for manufacturing purposes.

Sheet No. 13, Middle Bridge, Inverness county.

On the southwest Mabou river, and on the Mill river, small isolated gypsiferous areas occur, comprising a total area of 155 acres. They are practically all concealed, and, like Smith island, are associated with carbonate of lime reddish marls, and these, like the similar deposits at South Glencoe, are considered commercially important.

Sheet No. 14, Denys river, Inverness county.

Practically joining sheet No. 16 on the east, and sheet No. 15 on the s there is a section known as the Denys River section. It comprises a total g ferous area of 16·41 square miles.

The greater part is made up of concealed measures, and can only be tr by surface indications. The outcrops are few, the principal being near below Munroe Bridge, where the cliffs rise from 10 to 45 feet above the sea consisting of a grey and light grey, white and mottled white rock. Associ with it is seen a dark grey Carboniferous limestone. In texture it is a equally divided between compact and granular.

Its composition is shown in the following analysis:—

	Per cent.
Lime	33·17
Sulphuric anhydride	45·42
Water, loss on ignition	20·63
Insoluble mineral matter	0·93
	100·15

The evidence in other parts of the area where covered, is in favour of a white compact rock being concealed, but this can only be proved by a serie test pits or bore holes.

The position of the whole area on the border of the Bras d'Or lakes i desirable, that it is considered important, and worthy of complete investiga

Sheet No. 15, Malagawatchkt, Inverness county.

On the south side of Denys basin is a narrow gypsiferous area skirting shores of the Bras d'Or lakes from McKenzie brook on the northwest, to a half a mile southwest of Mathesons wharf, and continuing southwest by nume small islands and peninsulas to West bay. In this area of 6·44 square m including that portion of sheet No. 16 southwest of Denys basin, numerous crops of gypsum are seen as at Plaster island, and on the River Denys r George island, Green island, and Floda island.

Many of these outcrops are of little importance, being low and having small quantities above sea-level. Several, however, have sufficient promin to be considered as available supplies. The exposure on Donald McKinn farm, River Denys road, has a height averaging 50 feet, with a length of feet. This deposit, and its extension 2½ miles northwest to Pl island, shows probably the most important deposit in the whole area. At Pl island the exposure is from 10 to 40 feet in height on the shore, and covers area of 4 to 5 acres.

In texture and colour, this rock is a soft white compact variety, ha some anhydrite associated with it.

The following analyses are the result of average samples—No. 1, from the McKinnon outcrop, and No. 2, from the Plaster Island outcrop:—

—	I	II
	%	%
Lime	33·33	33·70
Sulphuric anhydride	45·00	45·25
Water, loss on ignition	20·75	20·78
Insoluble mineral matter	0·33	0·04
	99·41	99·77

Sheet No. 16, Washabuck peninsula, Victoria county.

This area includes the deposits at McKinnon harbour, Ottawa brook, Washabuck river, Nineveh, Little Narrows, Maciver point, Deadman point, McKay point, Boulaceet harbour, Lieutenant pond, Iona, Jamesville, Red point, and south side Whycocomagh bay. The total area is 25.54 square miles. Here all varieties of texture and colour may be found. The exposures are many and large. Anhydrite occurs frequently, outcropping in large irregular masses. This is especially true at Nineveh, and at Washabuck, the former showing a perpendicular face of 60 to 80 feet and a length of over 800 feet. At the latter place it shows on a road leading from Washabuck river to Little Narrows, for nearly a mile in width.

At Ottawa brook, the Newark Lime and Cement Company, of Newark, New Jersey, U.S.A., started operations in 1908. They have opened up several deposits, and built a railway connecting them with their shipping pier, constructed on the north side of Great Bras d'Or lake.

The rock at some of the points opened up, although a soft white compact variety, shows much disturbance, being badly fractured and folded; due to local pressures—probably the conversion of anhydrite into gypsum. At another point, only a few hundred feet distant, a dark carbonate of lime is seen graduating into gypsum. The lower left corner shows the lime, with streaks of snow-white gypsum. The right and upper side is a soft white compact variety of gypsum, showing very little disturbance. The composition of these two associated rocks is seen in the following analyses:—

—	I	II
	%	%
Lime	33·50	51·27
Magnesia	....	0·46
Ferric oxide	....	0·30
Sulphuric anhydride	45·32	0·04
Carbonic anhydride	....	40·73
Water, loss on ignition	21·15	0·86
Insoluble mineral matter	0·10	6·34
	100·07	100·00

At Little Narrows (south side), on the properties of M. J. McAskill and widow McAskill, very large exposures are seen. At the latter the face is about 100 feet high and over 600 feet long; the rock is an excellent quality of soft white compact variety with but few irregularities. It is situated on St. Patrick channel, about one mile from the shipping point, to which a practically level route could be secured.

Composition is shown by the following analyses:—

	Per cent.	Per cent.
Lime	33·30	33·67
Sulphuric anhydride	46·00	46·00
Water, loss on ignition	21·16	20·70
Insoluble mineral matter	0·24	0·20
	100·70	100·57

On the north side, at Little Narrows, the measures are concealed by an overburden of clay.

From Maciver point to Deadman point the deposits are not considered, at present, to be of any commercial value. This is also true of the greater part of the Washabuck river. East of Boulaceet harbour, although no exposures are seen, the indications on the surface are rather encouraging, and further investigations may develop a property of considerable commercial value.

At Lieutenant pond, and at Iona, exposures are seen near the sea shore, of sufficient area to make them of considerable value. The greater part of the rock is a soft white compact variety, with smaller quantities of granular texture, also some grey and blue rock are perceptible. Anhydrite also occurs with some prominence. The following analyses show the results of samples from this rock:—

—	I	II
	%	%
Lime	33·20	40·16
Sulphuric anhydride	45·60	55·60
Water, loss on ignition	21·06	4·52
Insoluble mineral matter	0·15	0·13
	100·01	100·41

At Jamesville, high precipitous cliffs of gypsum and anhydrite occur, which are in structure and colour very similar to those at Iona. The Intercolonial railway crosses this deposit and separates the greater part of it from water shipment. Just in the rear, and in close contact with the gypsum, stands a perpendicular wall of Carboniferous limestone, which has been quarried for commercial purposes.

At the south side of Whycocomagh bay, bounded on the northwest by the St. Patrick channel, and on the southeast by Denys basin, is situated a gypsiferous area of 6·78 square miles.

The surface indicates that the greater part of this is underlaid by gypsum, and that it is covered by an overburden of clay of varied thickness. Several exposures are seen in this area, the greater part of which is composed of a white compact variety, with lesser quantities of granulated white and grey, with some crystals of selenite.

Very little anhydrite is shown. An attempt was made about 40 years ago to operate a deposit here, known as 'The Boom,' and one cargo of good white rock was quarried and shipped, but the unfortunate loss of the ship and cargo before reaching its destination caused the discontinuance of further operations.

Analyses of average samples show:—

—	Granulated	Compact.
	%	%
Lime	33·33	33·73
Sulphuric anhydride	45·72	46·20
Water, loss on ignition	20·85	20·85
Insoluble mineral matter	0·19	0·06
	100·09	100·84

At McKinnon harbour, the measures are nearly all concealed. About 1½ miles east of the harbour there is an exposure showing a face of good white compact rock, 30 feet in height. The samples from this show the following composition:—

	Per cent.
Lime	33·13
Sulphuric anhydride	46·04
Water, loss on ignition	20·70
Insoluble mineral matter	·36
	100·23

On the south side of Red point and between McKinnon point and Oyster pond, occurs, in the bluff of the shore, a mixture of gypsum and limestone, associated with selenite, having large transparent plates or crystals, covered with a very plastic smooth red clay. The colour of the rock varies from a dark grey and mottled, to a pure white, having a compact texture. The clay carries small particles of gypsum, and might be classed as gypsite.

The following are the results of analyses of samples taken from this deposit:—

—	I	II	III	IV
	%	%	%	%
Lime	51·88	38·20	33·67	33·6
Ferric oxide and alumina	0·43	tr.	tr.	....
Sulphuric anhydride	0·96	42·16	44·77	45·4
Carbonic anhydride	40·76	2·49	....	....
Water, loss on ignition	0·57	20·83	20·80	20·9
Insoluble mineral matter	5·40	1·60	0·40	0·0
	100·00	100·28	99·64	100·1

No. I. Dark grey with particles of selenite.
No. II. Grey mottled.
No. III. Pure white.
No. IV. Selenite.

Sheet No. 17, Nyanza, Victoria county.

This section, together with Middle river and Baddeck river, comprises total gypsiferous area of 14·60 square miles. With the exception of three poin the whole is devoid of outcrops, and has an overburden of clay of varying thic ness.

At the rear of Alex. McGregor's house, a small outcrop of white granul rock appears, having a height of face from 10 to 20 feet, and an elevation 60 fe above the sea-level. On the road near Baddeck Bridge small hummocky ou crops are seen, having a belt of Carboniferous limestone running through t centre. On James McGregor's farm, near Baddeck river, another outcrop of few acres occurs, but both this and the preceding outcrop have so little elev tion above the sea-level that they are considered of little commercial value, b yond the fact that they may be used for local manufacturing. In the conceal gypsum areas of both the Middle and Baddeck rivers, high elevations might d velop deposits of great value.

The composition of samples taken from the exposures are shown in t following analyses:—

—	I	II
	%	%
Lime	32·99	33·1
Sulphuric anhydride	46·60	46·2
Water, loss on ignition	20·88	20·9
Insoluble mineral matter	....	....
	100·47	100·4

No. I. From near Baddeck Bridge.
No. II. From James McGregor's farm.

Cliffs of anhydrite, Great Bras d'Or lake, C.B.

Sheet No. 18, Port Bevis or Big harbour, Victoria county.

From Baddeck bay on the west to St. Ann bay on the east may be considered as one continuous gypsiferous bed, having an area of 15·83 square miles.

It contains many important outcrops of both gypsum and anhydrite. On the shores of the Great Bras d'Or lake, west of Port Bevis, extensive cliffs of anhydrite occur, and have been referred to in Chapter II, and shown in Plate XI. Another cliff, 70 feet high and 650 feet long, is shown in Plate X. The prominence of this mineral is greater on or near the shores of the lake, and again at the contact of these measures with the older rocks, and may be a conversion from gypsum by metamorphic action.

The farther it is possible to get from these points the freer the deposit seems to be from anhydrite. Thus, it is seen that the best exposures of gypsum are found at the head of Baddeck bay, about 1 mile from deep water shipping, where very little disturbance is apparent. These exposures occur in a valley where there are extensive outcrops of soft, white, compact gypsum, without any appearance of anhydrite.

At the rear of Margaret McKenzie's grant, and about 1 mile from McDonald point, similar conditions are seen; also on the farm of Alex. McKenzie, near his house, where a large bluff covered with clay has been tested to a small extent, and although only about 100 yards on the east from the exposure of anhydrite shown in Plate IX, and from a similar exposure about one-quarter of a mile to the west, this particular bluff, which shows but little disturbance, has evidence of being a good variety of gypsum, and no evidence of anhydrite. Extensive outcrops are also seen at South Gut, 2 miles, and 2½ miles west of South Gut; also at North Gut; but associated with these are some prominent exposures of anhydrite.

At Port Bevis a few years ago the Victoria Gypsum Company carried on extensive operations, but owing to increasing occurrence of anhydrite at depth, the place was abandoned. This is also true of a point west of Plaster mines, where a small quarry was operated many years ago (1875) by Mr. Duncan MacDonald, of Montreal, who exported annually about 5,000 tons. It has been noticed that both of these quarries are in the region of most disturbance.

The following analyses will show the composition as a fair average from this section:—

—	I	II	III	IV
	%	%	%	%
Lime	32·80	33·77	38·10	33·60
Sulphuric anhydride	46·08	44·63	53·16	45·45
Water, loss on ignition	21·07	21·05	8·72	20·70
Insoluble mineral water	0·18	0·27	0·26	0·20
	100·13	99·72	100·24	99·95

No. I. Sample from rear of Alex. McKenzie's house.
No. II. Sample from Margaret McKenzie grant.
No. III. Sample from a face 70 feet high and 650 feet long, east of Alex. McKenzie's house.
No. IV. Sample from near South Gut.

Sheet No. 19, Island point, Victoria county.

One of the most picturesque spots in all the gypsiferous districts is that on the south side of Boularderie island, and known as Island point, comprising an area of 232 acres. The point is about 2 miles long, and projects into St. Andrews channel, with good natural shipping facilities.

The deposit is made up of gypsum and carbonate of lime outcrops, the gypsum having greater prominence. The rock is white and snow-white in colour, with some grey intermixed, all a compact soft variety.

The following analyses show the composition:—

—	I	II
	%	%
Lime	32·24	33·33
Sulphuric anhydride	46·08	45·93
Water, loss on ignition	20·85	20·82
Insoluble mineral water	0·50	....
	99·67	100·08

On the northern side of Boularderie island, at Sutherland point, another small gypsiferous area occurs, but it has small commercial value.

Sheet No. 20, St. Ann, Victoria county.

In this section, at Goose cove and at Oregon, 4½ miles from the mouth of North river, occur small gypsiferous areas. At Oregon there are 134 acres; at Goose cove two areas, having a total of 230 acres. At the former place the measures are all concealed; at the latter large exposures from 40 to 60 feet in height are seen. One of these has been opened up and operated for several years by the Victoria Gypsum Company. Plate XI. It is situated 3½ miles by rail from their shipping pier at Munroe point. The rock in colour is white, light grey, and mottled white, the white having prominence. The outcrops indicate a soft compact variety, and operations prove this to be true to a depth of 30 to 40 feet; but during the summer of 1908, while sinking on the floor of the quarry, anhydrite was discovered in considerable quantities. The following analyses show the composition:—

PLATE XI.

Victoria Gypsum Company's quarry, St. Ann, C.B.

289—p. 56.

—	I	II	III
	%	%	%
Lime	42·80	33·20	32·87
Ferric oxide and alumina	tr.	....	....
Sulphuric anhydride	56·16	46·08	46·14
Water, loss on ignition	0·73	20·68	20·73
Insoluble mineral matter	0·80	0·30	0·02
	100·49	100·26	99·76

No. I. Sample from floor of quarry.
No. II. Sample of mottled white.
No. III. Average sample from stock pile.

Sheet No. 21, Saunders cove, Cape Breton county.

On the south side of Boularderie island, and 11 miles northeast of Island point, occurs a gypsiferous area of 299 acres. The measures are well exposed on the shores, and are made up of white granulated gypsum, between 15 and 20 feet thick, succeeded by greenish marls, mixed with streaks, veins, and nodules of pink and white gypsum and selenite; and much of it may be classed as gypsite. The limestone at this point occurs both above and below the gypsum.

Sheet No. 22, East bay, Cape Breton county.

On the north side of East bay and skirting its shores are several small deposits of gypsum, comprising a total area of 281 acres. The exposures are small, and varied in colour, comprising white, grey, dark grey, blue, black, and pink. This great variety of colour deteriorates the value, except for fertilizer purposes.

Situated about 2½ miles from deep water shipping, at the head of East bay, there is a gypsiferous area comprising 2·40 square miles of much importance. It is easily accessible, and shows an exposure from 20 to 60 feet high over a large portion of its area. The greater part of the rock is a very pure compact white variety, with lesser quantities of soft white granular, with no evidence of anhydrite.

The following analyses show the results of average samples taken from these deposits:—

—	I	II	III
	%	%	%
Lime	32·87	33·10	31·62
Sulphuric anhydride	46·07	45·95	42·96
Water, loss on ignition	20·89	20·85	20·44
Insoluble mineral matter	0·12	0·07	3·60
Ferric oxide	....	....	0·95
	99·95	99·97	99·57

Nos. I and II. From the large deposit at the head of East bay.
No. III. Analysis of the dark variety from north side of East bay.

Sheet No. 23, Tom river, Richmond county.

On the southeast side of Great Bras d'Or lake is a gypsiferous area of 2 square miles, comprising Campbell cove, Hay cove, and McNab creek, in whi occur several outcrops of gypsum. Some of these outcrops consist of a very e cellent, snow-white, compact variety, resembling alabaster; while others, espe ially at Tom river, show an excess of lime, and have been referred to in Chapt II. It is free from all evidence of anhydrite, and is easily accessible to wat shipment.

The following analyses show the average quality of the rock:—

	I	II	III
	%	%	%
Lime	32·95	34·04	33·02
Sulphuric anhydride	46·64	44·28	46·68
Water, loss on ignition	20·93	21·07	20·91
Insoluble mineral matter	0·13	0·67	0·26
	100·65	100·06	100·87

Sheet No. 24, Richmond county, N.S.

At Black river, south side of West bay, occurs a gypsiferous area of 1·81 square miles. This is reasonably accessible to water transportation and may be considered as a property having commercial value. The outcrops are prominent, and are principally on the banks of the river, about 1 mile, and 2½ miles from its mouth. The greater part of the rock is a white compact variety. Small quantities are coloured with the oxide of iron.

The following analysis shows the results of an average sample taken from the exposures:—

	Per cent.
Lime	32·11
Magnesia	tr
Ferric oxide and alumina	0·44
Sulphuric anhydride	45·82
Water, loss on ignition	20·35
Insoluble mineral matter	0·48
	99·20

Sheet No. 25, Madame island, Richmond county.

This sheet comprises not only the deposits of Madame island, but of Port Richmond, on the north side of Lennox passage, and a very small deposit near Pirate harbour in Guysborough county, making a total gypsiferous area of 6·57 square miles.

The most important of these deposits is that on the north side of Madame island, and the south side of Lennox passage, where there is a large gypsiferous area of 3·77 square miles. The outcrops of gypsum in this area having most prominence are situated about 1½ miles west of Lennox Ferry landing, and about 1 mile from the shore. At this point the exposures cover many acres in area, and have a height of from 30 to 70 feet. Here, years ago, H. C. Higginson, of Newburgh, New York, operated a quarry, and exported large quantities of the crude material to the United States. The gypsum is a white compact variety; but it has, irregularly associated with it, much anhydrite. The occurrence of this mineral, no doubt, had much to do with the closing of the quarry, although there still remain large quantities of good gypsum. This, together with excellent natural shipping facilities, and the increasing demand for the product, should be an impetus to reopen and operate this extensive area.

Analysis:—

	Per cent.
Lime	33·33
Sulphuric anhydride	45·32
Water, loss on ignition	20·92
Insoluble mineral matter	0·22
	99·79

Other small exposures occur on Evans island, and Freeman island; also at Carlton head, and north of Port Richmond, but these have little prominence, and evidence of anhydrite gives them little commercial value.

A smaller area, but having more prominent exposures, occurs about 2½ miles east of the town of Arichat. Here a white compact variety of gypsum is seen in the side of a high hill, which would give a working face of about 75 feet in height. Associated with this there is a small quantity of blue anhydrite, which diminishes somewhat the commercial value of the deposit.

Analysis of gypsum from Arichat:—

	Per cent.
Lime	32·86
Magnesia	0·13
Ferric oxide and alumina	0·14
Sulphuric anhydride	45·47
Carbonic anhydride	0·96
Water, loss on ignition	20·00
Insoluble mineral matter	0·08
	99·64

Sheet No. 26. Askilton, Inverness and Richmond counties.

In this section we have what may be known as the Hastings area, of 75 acres, at Port Hastings; the Beaver Dam Lake area of 1·6 square miles on the border line of Inverness and Richmond counties, and about 4½ miles east of Point Tupper; the Askilton area of 1·8 square miles, at Askilton, 3½ miles from the Intercolonial railway, or about 6 miles east of Port Hastings. Also a small area about 1½ miles south of Askilton, of 302 acres, on Inhabitants river.

The Inhabitants River area, and the Beaver Dam Lake area have very little importance, being situated in low ground. The Beaver Dam lake is only traceable by the pits or kettle holes, and hummocky ground. In the banks of Inhal tants river small outcrops are seen, but both areas seem to be covered heavi with clay.

The Hastings area is small. The greater part seems to have been erode by the sea, and now forms a small inlet or cove having a floor of gypsum. Tl greater part of what remains is in outcrops from 30 to 60 feet high, showing variety of colours and texture with considerable anhydrite.

The Askilton area is the most important in this section from all points view. It has large outcrops, some as high as 70 feet above drainage level. ar the greater part is an excellent white compact variety, with smaller quantiti of granular.

The Strait of Canso, the natural outport for the deposit—being an op port all the year—makes this deposit desirable, especially to those who expo large quantities of crude rock, as it is the nearest deposit to a winter port the Province.

The following analyses from samples of the different deposits will serve show the average composition of this rock:—

—	I	II	III	IV	V
	%	%	%	%	%
Lime	40·48	33·80	33·20	34·20	33·
Sulphuric anhydride	55·48	46·08	46·32	45·92	45
Water, loss on ignition	3·90	19·86	20·85	20·65	20
Insoluble mineral matter	0·44	....	0·14	....	0·
	100·30	99·74	100·51	100·77	100·

No. I and II. Average samples, Hastings area.

No. III and IV. Average samples of white compact, Askilton area.

No. V. Sample of the granular, Askilton area.

GYPSUM DISTRICT 'B.'

Sheet No. 27, Tracadie harbour, Antigonish county.

Sheet No. 28, Pomquet harbour, Antigonish county.

Sheet No. 29, Antigonish harbour, Antigonish county.

The gypsum deposits in this district, although for convenience shown three map sheets, are all included in one gypsiferous area, consisting of ov 125 square miles, and practically continuous. It is, therefore, deemed advi able to consider them together.

Referring to this district, Dr. Honeyman[1] says:—'Succeeding the conglon erates of Antigonish mountains, and reposing directly upon them, we have lim

[1] United States, Institute of Natural Science, Vol. I. (old series), Part 4, p. 1

stone of considerable thickness. Succeeding these limestones, we have an enormous bed of gypsum. Its length is nearly equal to that of the associated limestone. It appears at the forks of James river and the Ohio river; it passes over nearly in the course of James river until it reaches within one hundred paces of the limestones; its mountain side runs parallel with the limestones, Braley brook running between and along the bottom of the abrupt and lofty gypseous wall for about 3 miles. After parting with the brook the gypsum pursues its course until it reaches Right river, nearly a mile north of the town. After an apparent break of 2 miles, it again appears on the east side of the Sugar Loaf, and proceeds onwards into St. George bay; its land terminus being Ogden's lofty cliff.'

In the above we have the description of the northern boundary, about 16 miles in length. Its breadth varies from 2 to 6 miles, or more, and is made up of alternating beds of gypsum and Carboniferous limestone. It stretches southwardly through the harbour, and up the west side of South river, and continuing southwardly may be traced by sink pits and conical mounds, under the town of Antigonish, and thence to West river, where it again outcrops, and terminates against the metamorphic hills on the west side of the river.

Coming back to South river, these measures branch off more southerly to St. Andrews and Glenroy, and thence eastwardly, following closely the contact between the lower Carboniferous measures and the metamorphic rocks, to Barrie head, east of Tracadie harbour.

Although large quantities of gypsum are found in the southern and western part of the district, which at some future date may be considered important, yet those nearer the east and the northeast, particularly in the vicinity of Antigonish harbour, are much superior; in fact it is very difficult to find exposures better both in quantity and quality, many of them being over 100 feet high, some twice this height, and covering an extensive area. Much of the rock is the very best white compact, having the appearance of alabaster.

It is regrettable that, while the area contains practically inexhaustible quantities of gypsum of the very best quality, it is inaccessible to transportation facilities.

The principal harbour (Antigonish)—like those described on the east coast of Cape Breton island—has sufficient depth of water for shipping, but is silted up at its entrance by sand that prevents water transportation; while the long rail haul by the Intercolonial railway, which passes through part of the district to the Strait of Canso, makes transportation by it prohibitive, especially for crude material. The distance to Mulgrave, the nearest port, is about 40 miles.

GYPSUM DISTRICT 'D.'

Sheet No. 30, Westville, Pictou county

In this section two small gypsiferous areas occur, comprising a total area of 517 acres. The larger is about one mile north of the Pictou coal fields. It is cut by the Intercolonial railway (Pictou Town Branch), and the Intercolonial

Coal Company railway connecting their mines with their shipping pier at Gran ton. This area, together with the smaller one, 2½ miles farther west, con sists principally of concealed measures, made up of alternating thin beds Carboniferous limestone, gypsum, and marls; their value consists in being acce sible to shipping facilities and their close proximity to the coal fields for manu facturing purposes.

Sheet No. 31, Bridgeville, Pictou county.

On the Nova Scotia Steel Company's branch railway, 6 miles south Ferrona Junction, on the Intercolonial railway, a gypsiferous area occurs, con sisting of 4·32 square miles. The exposures are more prominent than those Sheet No. 30, but they are 18 miles by rail from a shipping port.

The rock consists of a compact white and pink variety, showing considerab anhydrite, referred to in Chapter II.

Sheet No. 38, East mountain, Colchester county

In this section, 1¾ miles from the railway, are four small isolat areas known as the S. Roode area, comprising 20 acres, and consistin of a soft grey gypsum, which has been utilized to some extent as a fertilize and the George Thompson area, 90 acres, the exposures consisting principal of a translucent anhydrite. There is, however, some evidence of alabaster bein here, but so much of the measures are concealed that it is difficult to make an exact determination. This deposit is 2½ miles from the railway; the Jam Clifford area, 65 acres, measures all concealed, 1¾ miles from railway; and t Elisha Archibald area, 55·2 acres. The rock here consists of a snow-white co pact variety, with some smaller quantities showing granular crystallization, al some alabaster. It is 1¼ miles from the railway, and if the alabaster proves be a prominent constituent it may be considered of commercial value.

—	I	II	III	IV
	%	%	%	%
Analyses:—				
Lime	33·12	41·20	32·80	33·[illegible]
Magnesia	......	......	......	0·[illegible]
Sulphuric anhydride	46·68	58·36	45·92	45·[illegible]
Carbonic anhydride	......	......	......	0·[illegible]
Water, loss on ignition	20·63	......	20·04	20·[illegible]
Insoluble mineral matter	......	0·28	0·92	......
	100·43	99·84	99·68	99·[illegible]

No. I. Geo. Thompson: associated with large quantities of pure wh anhydrite.

No. II. Geo. Thompson: pure white anhydrite, associated with No.

No. III. E. Archibald: white compact.

No. IV. Samuel Roode: greyish-white.

Sheet No. 39, Shorts lake, Colchester county.

In this section there is a large, tortuous, gypsiferous area of over 15 square miles. It is the eastern extension of the lower Carboniferous measures described on page 39, which extends westwardly across the Shubenacadie river and through Hants county. The topography at this particular location is generally low and level, and although there are some outcrops of prominence, very much the greater part consists of concealed measures. Beginning at the northwest corner of this sheet, on the farm of John Irwin and the adjoining properties situated about 3½ miles east of the headwaters of the Cobequid bay, occur some small outcrops. Here the gypsum varies much in colour and texture, and shows an excess of carbonate of lime in its composition. As far as could be observed it is only suitable for fertilizer purposes. Following the line of contact eastwardly at Hilden, miles west of the Intercolonial railway, outcrops of blue and white, of both granular and compact varieties, show considerable prominence on the estate of James Morgan. Continuing southwardly and eastwardly, and crossing the railway near Brookfield, we have numerous outcrops of more or less prominence, on the farms of Leonard Carter, James Lockhart, Alonzo Lockhart, John McCulloch, and J. J. Snook. The gypsum here is more regular in quality and texture, but where it occurs close to the contact it usually shows considerable anhydrite.

About 1½ miles south it again crops out on the property of Robert Benjamin; and at Upper Pleasant valley also, south and west of Shorts lake; and again at Little river, east of the railway; on the Stewiacke river; and near Ramsey post-office, on Wallace brook.

Unless, by testing, some superior variety of gypsum should be discovered, as, for instance, snow-white or alabaster—which is quite probable—this section can only be considered commercially valuable for a manufacturing industry for local purposes.

The following analyses show the average composition of the different deposits sampled:—

—	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
	%	%	%	%	%	%	%	%	%	%	%	%	%
Lime	38·20	39·88	33·00	33·00	33·80	31·28	31·60	32·88	32·60	34·00	33·00	33·08	33·00
Magnesia	1·06	....	....	....	....	....	....	....	0·20	1·08	....	....	....
Ferric oxide alumina	....	....	....	....	0·56	1·80	1·00	....	....	....	....	....	....
Sulphuric anhydride	53·80	51·28	46·20	45·72	42·04	42·44	42·64	45·52	45·88	46·72	45·76	45·92	46·06
Carbonic anhydride	1·17	1·81	....	....	3·44	trace.	....	....	....	....	....	....	....
Water, loss on ignition	5·16	7·16	20·85	20·92	19·32	1·63	20·29	20·02	21·00	17·77	20·78	21·20	20·90
Insoluble mineral water	0·10	....	....	....	0·80	1·20	4·00	0·40	0·50	0·40	0·90	0·10	0·10
	99·49	100·13	100·05	99·64	99·96	99·35	99·53	99·62	100·18	99·97	100·44	100·30	100·06

No. I. Leonard Carter: anhydrite occurring in close contact with carbonate of lime.
" II. A mixture of light grey and white, from Leonard Carter's.
" III. James Lockhart: white, compact.
" IV. John McCulloch: white, compact.
" V. Robert E. Benjamin, white, and greyish-white.
" VI. J. J. Snook: a red pinkish mixture associated with marls.
" VII. Robert E. Benjamin: black compact, somewhat columnar in structure.
" VIII. Alonzo Lockhart: soft white granular.
" IX. White granular, from John Irwin.
" X. White, streaked with red, from adjoining property.
" XI. Samples from Kennedy farm, Pleasant valley.
" XII. Blue, from James Morgan estate at Hilden.
" XIII. White, from James Morgan estate at Hilden.

Sheet No. 40, Shubenacadie river, Colchester and Hants counties.

At the mouth of the Shubenacadie river, on the east side, occurs a black Carboniferous limestone, known as black rock, carrying small veins of manganite. Succeeding this is a series of soft marls and sandstones, filled with veins of reddish fibrous gypsum running in all directions, and it is not until Pitch brook is reached that we meet solid gypsum exposed in prominence. Here, about 1 mile from the shore, occur massive beds, which extend almost continuously eastward to Beaver brook, and to Irvin lake, described in No. 39. At Pitch brook the gypsum is light grey in colour, and has a compact texture. Many years ago the deposits were operated, and the product exported to the United States. At Beaver brook the rock is a compact white variety, with some alabaster showing in some of the exposures; however, anhydrite has prominence. Ascending the river on the western side there is a small area known as Stephens area, where a good white compact variety of gypsum is seen, associated with soft reddish blue marls. Here is the largest deposit of fibrous gypsum known in the Provinces, occurring in veins running through the marls in all directions, often 12" and 18" wide, and when cleaned from the associated marls is very pure. In 1869, these deposits were operated for the fibrous variety, and a mill was erected at Noel, 15 miles from the deposit, at a cost of $12,000, for manufacturing the product into terra alba. These works were destroyed by fire the following year, and all operations abandoned.

Proceeding up the river, on the west side, the next deposit of importance is that of Capt. John Graham, just above and opposite Eaglesnest point. This, formerly known as Big Rock, presented a snowy white front to the river, and for many years was operated for export purposes.

It is a massive bed arranged in layers and bent in conical shape; the base and interior showing anhydrite, and the whole resting on a base of Carboniferous limestone. It is here the Windsor series of the lower Carboniferous

crosses the boundary line (Shubenacadie river) into Colchester county, and a this point it has a width of less than 1 mile, and west, about 1½ miles, it tape to a mere connecting link, but soon widens again on the Fivemile and Kenne cook rivers. Proceeding on the western side of the river, 1 mile south of th Fivemile river, again the gypsiferous area is met with in prominent outcrop of gypsum, which are almost continuous for several miles. At Rose poin Urbania, and Admiral rock, massive white beds are exposed on the river bank from 40 to 60 feet in height; and not only at the river bank, but from one t three miles west prominent exposures occur of excellent quality.

Crossing the river near Fort Ellis point, and descending again on the easter side large exposures are seen; but not in such prominence as those on the oppo site side of the river. At Green Oak, on the property of Thos. Phillips, larg and prominent exposures of white, snow-white, and blue gypsum occur, in com pact crystallization. This property is near the river, where shipping facilitie are good, and in the past was operated quite extensively. Again, on the propert of G. W. Dart, and Tupper Fisher, outcrops occur, but here an excess of car bonate of lime is shown. The gypsiferous area included in the above descrip tion is 14·14 square miles in extent.

It will be seen by the above that in this section there is practically an un limited supply of gypsum of good quality; and at one time considerable busines was done exporting the crude material, but many causes have militated agains the successful operation of these deposits. Operations were carried on in th days of small sailing vessels owned by those who were familiar with the tides o the Shubenacadie river, but as the size of vessels increased, and before th steamboat was known on this river, the plaster trade became controlled by a few and these deposits were the first to suffer. To those interested in this trade i may be worthy of note to mention that the tide at the mouth of the Shubena cadie rises 30 feet in three hours and recedes in the same length of time. A Eaglesnest point the bore at high tides is often 10 feet high.

The following analyses will serve to show the different qualities of rock in this section:—

—	I	II	III
From Beaver brook—	%	%	%
Lime	36 80	33·20	33 72
Ferric oxide and alumina	0·40	...	...
Sulphuric anhydride	51·44	46·40	46 00
Water, loss on ignition	11·73	20·79	20·94
Insoluble mineral matter	...	...	0·35
	99·87	100·39	100·01

No. I. The interior of a boulder of anhydrite which has been expose for about 25 years.

" II. An outside coating about 1" thick taken from No. 1.

" III. White compact variety of gypsum occurring in the same de posit.

—	I	II	III	IV
	%	%	%	%
From Pitch brook—				
Lime	32·80	32·88	32·20	33·80
Sulphuric anhydride	45·72	44·92	44·64	44·92
Water, loss on ignition	20·60	20·47	20·44	20·54
Insoluble mineral matter	1·30	1·70	2·30	0·80
	100·42	99·97	99·58	100·06

No. I. Gregory Yuill: grey fibrous.
" II. Gregory Yuill: grey massive.
" III. Constine Wheelock: dark grey with radiating structure.
" IV. Samuel Creelman: light grey, massive.

—	I	II	III	IV	V
	%	%	%	%	%
From Green Oak—					
Lime	33·20	33·20	4·40	32·80	32·92
Ferric oxide and alumina	....	0·40	2·50	....	0·40
Sulphuric anhydride	47·04	45·28	4·24	46·16	45·16
Water, loss on ignition	19·22	20·66	5·01	20·94	21·00
Insoluble mineral matter	·30	0·80	79·52	....	....
	99·76	100·34	95·67	99·90	99·48

No. I. General sample of the rock from property of G. W. Dart.
" II. Sample with dark bark-like incrustation.
" III. Clay mixed with the gypsum incrustation.
" IV. Pure white, granulated, from the property of Thos. Phillips.
" V. Pure white, compact, from the property of Thos. Phillips.

—	I	II	III
	%	%	%
Lime	32·92	32·80	38·40
Magnesia	tr.	tr.	tr.
Ferric oxide and alumina	tr.	....	1·60
Sulphuric anhydride	46·44	46·24	54·44
Carbonic anhydride	....	tr.	....
Water, loss on ignition	20·93	20·65	5·76
Insoluble mineral matter	0·20	1·00	0·60
	100·49	100·69	100·80

No. I. A snow-white, compact sample, from the Stephens property.
" II. Soft greyish white rock, from an exposure on Capt. John Graham's farm.
" III. Anhydrite, from same location as No. 2.

Sheet No. 48, Elmsdale, Halifax county, and Hants county.

In this section we have one of the largest gypsiferous areas in the Provi comprising 55 square miles and containing inexhaustible and valuable depo of gypsum. Prominent exposures occur about 1 mile southeast from El dale station, near Keys corner, and 1¼ miles farther on. Follow the contact northeastwardly and lying unconformably with the Carb ferous limestones, on the Cambrian quartzites and slates, are several outc of soft white, greyish white, and blue gypsum. Three miles northeast of El dale and east across the Shubenacadie river, quite extensive deposits of v pure selenite occur, near a very dark gypsum outcrop, known as the Black R gypsum quarry.

East and north of the Intercolonial railway, at the Horne settlement on shores of Grand lake, further deposits of selenite occur, with more or less pro nent deposits of gypsum; and again at Ninemile river, 6 miles from the way, what is probably the most extensive outcrop of gypsum in the whole sec occurs on the Thompson property. The outcrop is more than a mile in len and has a maximum height of 60 feet. The greater part consists of a w compact variety. These deposits, however important, are not considered c mercially valuable on account of the distance from Halifax, the nearest s ping port.

Sheet No. 49, Gay river, Halifax and Colchester counties. Gypsiferous 75·60 square miles.

Sheet No. 50, Musquodoboit, Halifax county. Gypsiferous area 31·38 sq miles.

Sheet No. 51, Stewiacke river, Colchester county. Gypsiferous area 13·95 sq miles.

Sheet No. 52, Newton mills, Colchester county. Gypsiferous area 22·32 sq miles.

To the four above mentioned sections, containing in all an area of 14 square miles, very little attention has been paid. There is no question but they contain many of the largest and best deposits in the Maritime Provi but their location being far away from any means of transportation, des their commercial value. It is not pleasant to think of such extensive depos great purity being inaccessible, but a glance at the maps will show that be a few deposits on the northwest portion of Gays River map, all others are from transportation facilities, many being from 18 to 30 miles from the ne railway connexion. Should the proposed Halifax and Guysborough railw constructed through the Musquodoboit valley, it will materially improve the tion of many of these deposits, and be a strong incentive to encourage man turing in this district.

GYPSUM DISTRICT 'E.'

Sheet No. 41, South Maitland, Hants county.

The eastward continuation of the Kennetcook River valley is the valley of the Fivemile river, both rivers having their origin in close proximity, the Kennetcook flowing westwardly to the Avon, the Fivemile river eastwardly to the Shubenacadie. The Dominion Atlantic railway (Midland division) follows these valleys for nearly 30 miles west of the Shubenacadie river, which makes the gypsum deposits in this section very accessible.

On this sheet there are three gypsiferous areas, comprising a total of 9 square miles.

The most important of these is that at Latties brook, which is a continuation of the Windsor series eastward. It is here that the Windsor Plaster Company has a quarry and gets a partial supply for its calcining mill at Windsor. The quarry is situated near Burtons station, on the south side of the railway, and has an exposed face 40 feet high, covered with from 10 to 15 feet of clay. Attempts have been made, with a considerable degree of success, to remove this clay by the hydraulic method.

The rock is a white compact variety, well suited for the manufacture of plaster of Paris. This bed may be followed westward for some miles, but there are only a few outcrops, the greater part being concealed under a heavy overburden of clay. North, about 1 mile, near the public highway, prominent outcrops are again seen, but the rock is not as good in colour or texture as at Burtons.

Going east from Burtons we meet precipitous cliffs, from 75 to 140 feet in height, and over 2,000 feet long, on the Lawrence property, at Andrew Hayes (known as The Cave), and on the Royles property. On the Geary property, about 150 feet north of the railway and having a strike about parallel with it, is another exposure, with a length of 1,400 feet, and an average height of 85 feet.

On the Hayes property, the upper parts of the cliff show considerable disturbance, and are badly folded and contorted; while near the base the beds are more even in structure. The rock on this face shows considerable anhydrite, but on the south or opposite side of the ridge, where the rock has more covering, it is a good white gypsum, with some greyish white and blue associated. The face continues westwardly, with practically the same height, to the Lawrence property and has a stratification more horizontal and even. In other conditions it is similar to the Hayes property.

On the Geary property, the rock again shows disturbance, with considerable anhydrite, and veins of dark carbonaceous and reddish gypsum of inferior quality cutting through it.

The natural shipping port for the deposits of this area would be the Shubenacadie river (distant from 3 to 5 miles), but it would necessitate the construction of a shipping pier above the railway bridge. Unfortunately, not sufficient attention was given to draw efficiency in the construction of this bridge, and the provision then made for this purpose is not suitable for modern sh ping; and, therefore, makes what would be otherwise desirable gypsum prop ties (not only the above described, but several others on or near the Shuben eadie river), practically inaccessible for export purposes.

The next area of importance is that at Gleneoe, which was mentioned in t description of sheet No. 40. It is to the south, and some distance from the v ley of Fivemile river and on very much higher ground. The shipping p for this is on the Shubenacadie river, about 2 miles above the mouth of the Fiv mile river.

Going north on this sheet to Selma, near the head of Cobequid bay the occurs a small isolated gypsiferous area of 1·7 square miles. The topograp of this is generally low dike lands, and the outcrops, which have but litt prominence, occur about 2 miles from the shore. The rock is a grey slaty stru ture, with small quantities of white granular.

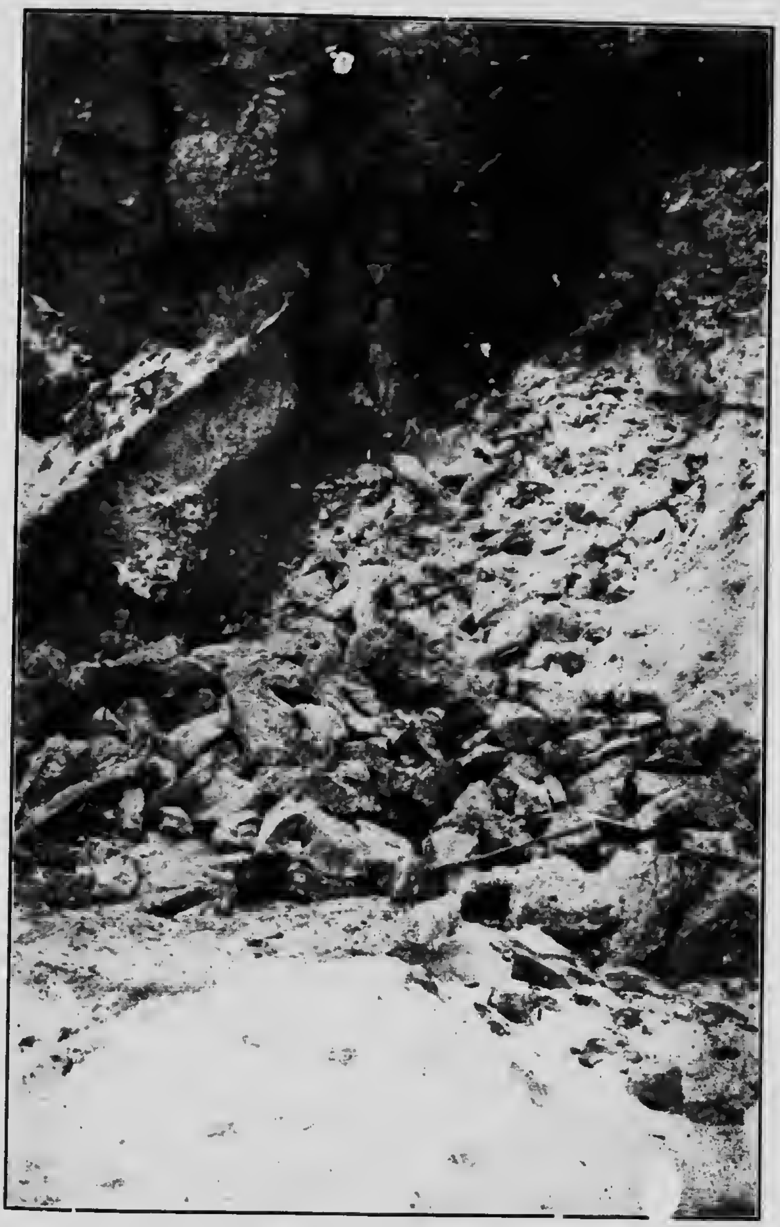
The following analyses will give the general average composition of e posures in this section:—

—	I	II	III	IV	V	VI	VII
	%	%	%	%	%	%	%
Lime	39·60	34·20	35·60	34 20	38·80	33 32	32·8
Magnesia	tr.	.....	.....	.....	.....	.....	.....
Ferric oxide and alumina	.....	0·40	0·40	0·40	.....	0·28	0 1
Sulphuric anhydride	55·20	46·68	37·92	45·60	53·40	46·48	45·6
Carbonic anhydride	0·78	.....	6·58	tr.	.....	.....	.....
Water, loss on ignition	4·05	17·15	17·30	20·10	8·05	20·65	20·4
Insoluble mineral matter	tr.	0·92	2·20	.....	·40	·12	1·6
	99·63	99·35	100·00	100·30	100 65	100·85	100·6

No. I. Andrew Hayes property, from high face near cave.
" II. Andrew Hayes, south side.
" III. Burgess property, Glencoe, dirty dark grey.
" IV. Burgess property, Glencoe, soft white, slightly granular.
" V. From the Garry property, or Midland railway.
" VI. Windsor Plaster Company's quarry at Burtons, soft compac rock.
" VII. From Selma quarry, grey shaly variety.

Sheet No. 42, Noel, Hants county.

This sheet besides showing the continuation of the deposits of the Kennet cook valley, where there are several important exposures of gypsum similar in quality and texture to those that have been described in this valley, also shows a northern gypsiferous area belonging to the Windsor series. This branches of



O'Brien quarry, showing pipe or blowhole, also structure of rock

from the Kennetcook valley near Burtons, and follows a westwardly course skirting the older Devonian rock, to the Avon river on the west, and forms the northern boundary of the lower Carboniferous basin of Hants county.

In this section important exposures of all varieties occur. Many of them, however, being so far away from transportation facilities, are not considered commercially valuable. Among these may be mentioned the deposits on the Petite river, those on the West Branch of the Tennycape river, on Robinson brook, and those east of Northfield, together with those in an isolated area 1½ miles north of the Kennetcook river.

The first to be considered are those at Noel lake. Here the gypsum outcrops on both sides of the lake and shows beneath the water in the lake. The greater part of the deposits appear as a white compact variety of excellent quality. In some places anhydrite occurs, in a form peculiar to this place, not in veins, masses, or beds, but in round spire-like pinnacles protuding through the gypsum.

On the west side of the lake the O'Brien Company has been operating for a few years, and exporting the crude rock to the United States. The quarry is situated in a hollow between 30 and 40 feet below the surrounding country, and has a height of face equal to that depth. It is drained by natural watercourses through the rock. The top of the rock is covered with blow or pipe holes—one shown in Plate XII—which is 30 feet below the surface. This figuro shows the structure of the rock in the deposit. At the east of the lake, on the property of J. S. O'Brien, some development work has been done, which has proved the existence of large quantities of gypsum of excellent quality.

The present system of transporting this rock to the shipping pier (3½ miles distant) is by horses and wagons, which makes an excessive cost. A line of railway, [illegible] ry easy location, is proposed for future development, and, if constru[illegible] ake this property one of the most desirable on the Minas basin.

Th[illegible] osit of importance west of the above is one situated in the rear of Minasville, about 1½ miles from the shore. This property has an exposure averaging 50 feet in height, and over 1,500 feet in length. It is a good white compact variety of gypsum, showing but few irregularities. The topography of the country between the shore and the deposit is such that it would be difficult and expensive to construct a railway connecting the two points, but it has been proposed to make Tennycape harbour the shipping port, and build a railway to that point, a distance of 3½ miles.

Samples have been taken from the above described deposits, and the res
are given in the following analyses:—

—	I	II	III	I
	%	%	%	%
Lime	32·60	35·00	33·20	3
Magnesia	....	....	....	.....
Ferric oxide and alumina	....	0·20	0·20	.....
Sulphuric anhydride	46·84	48·96	45·32	4
Carbonic anhydride	....	....	1·15	(
Water, loss on ignition	20·80	14·90	20·55	2
Insoluble mineral matter	0·20	0·60	....	.....
	100·44	99·66	100·42	10

No. I. From J. S. O'Brien property east Noel lake, white to sı
white compact variety.

" II. Average sample from the O'Brien Company, west of
lake, greyish white, compact gypsum.

" III. Average sample from the Minasville property, compact, w
to snow-white.

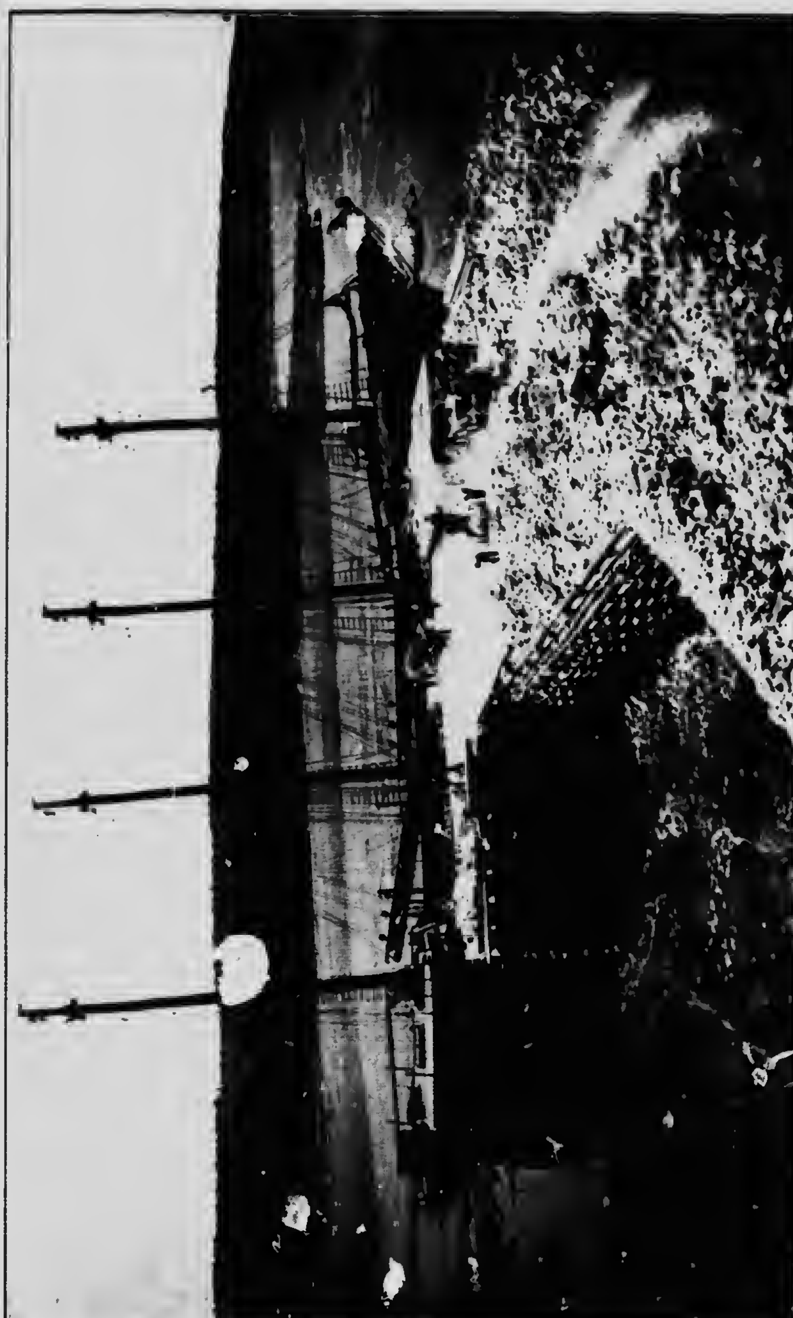
" IV. Best quality from Minasville property, snow-white, com

Sheet No. 43, Walton, Hants county.

Following westwardly from No. 42 the gypsum can be traced almost
tinuously, by outcrops and other characteristics, the whole length of the gy
ferous area, which in this sheet consists of 33·7 square miles. The most imp
ant deposit is that at Walton which is shown in Plate I. It is one of the
deposits in the county, having a face 100 feet high, and may be followed,
a constant exposure, for over 2,600 feet, and continues for miles with a se
of extensive outcrops.

The Walton deposit, which has been operated intermittingly for near
century, is now producing from 40,000 to 50,000 tons annually; operated by
Albert Parsons. The rock is a greyish white and blue compact variety, show
comparatively small quantities of anhydrite occurring in lenticular veins
rounded by gypsum, graduating with increasing or diminishing promin
into each other. At this point the pipe or blow holes are very characteri
having a circular area, with perpendicular walls and rounded bottoms.
rock, where excavated, has no covering of clay, and everything, except for
material, that will not pass through a coke fork, is shipped. The deposit is s
ated 1 mile from the shipping pier and the rock is hauled there with h
and carts. At present the whole output is taken by Messrs. J. B. King & Co
New York, and transported by this firm in its own barges. Plate XIII sho
barge loading at the Walton shipping pier.

PLATE XIII.



Loading gypsum at Walton shipping pier.

—	I	II	III	IV
	%	%	%	%
Lime	33·20	40·00	32·40	33·32
Magnesia	....	....	....	....
Ferric oxide and alumina	0·20	0·36	....	0·32
Sulphuric anhydride	46·84	57·[illegible]	46·28	44·28
Carbonic anhydride	....	....	tr	1·75
Water, loss on ignition	17·40	1·50	20·56	19·50
Insoluble mineral matter	2·00	0·52	0·20	0·48
	99·64	99·50	99·44	99·65

No. I. Average sample from stock pile at Walton quarry, light blue compact.

" II. Anhyde from Walton quarry. This rock has a very sandy appearance and is full of grit.

" III. Sample from first level above and east of quarry floor, at Walton, bluish grey, compact.

" IV. Sample from South Mountain deposit, at Walton.

Sheet No. 44, Cheverie, Hants county.

By many it has been considered that the gypsiferous area occurring at Cheverie was a continuation of the Windsor and Shubenacadie series, but this is not correct. They are separated by over 2 miles of intervening Devonian rocks at their nearest point, which is near Goshen, shown on the east side of the sheet.

Cheverie, consisting of an area of 4·3 square miles, is situated on the south side of Minas basin, about 6 miles east from the mouth of the Avon, and has good water transportation facilities. Here operations have been carried on intermittingly for many years. Outcrops occur at the shore, in high cliffs, associated with much anhydrite, and carbonate of lime in close contact. They also have prominence, and have been operated in the past, about a mile from the shore, where the rock appears to be freer from irregularities.

The present operations are carried on at the shore, at points known as the Cove quarry and the Upper head. The Lower head occurs about one mile distant, on the north side of Cheverie creek, in a small isolated area.

The Cove quarry, shown in Plate XIV, is about 500 yards from the beach where the shipping pier is located. The gypsum is covered with clay from 10 to 15 feet thick, and underlain with anhydrite. The gypsum and anhydrite graduate from one to the other without any particular line of demarcation.

On the right of this illustration is shown a tunnel, opened for underground mining and to develop deposits on the opposite side of the public highway, which runs near the face of the quarry. In Plate XV is shown the Upper Head quarry, which is on the beach and a few hundred yards east of the shipping pier. The high tides of the Bay of Fundy do the work of cleaning the quarry, by was the debris away from the rock. This rock is principally anhydrite with gypsum intermixed.

The Lower head is a very similar rock to the last, but carries petrol in embedded cells, from which small quantities have been collected du blasting operations. With this as partial encouragement, a company formed to bore in this section for oil, and a record of one of the bore holes, down about half a mile from the shore, is given in Vol. XV, p. 161 AA, of Geological Survey of Canada. A section of this bore hole is shown in Fi It is interesting, as it shows the occurrence of gypsum at different depths, greatest body of white gypsum being between 130 and 370 feet from the face. It is unfortunate that no record is given of the dip of the rock.

The following analyses are from samples taken from this section, and serve to show the composition; also an analysis made by Prof. F. E. En hardt, of Syracuse, N.Y., and kindly furnished by Mr. A. A. Hayward, of H fax, of the brine from the Cheverie bore-hole mentioned above:—

——	I	II	III	IV	V	VI
	%	%	%	%	%	%
Lime	32·80	32·72	40·80	32·60	42·20	31
Magnesia	....	....	....	....	....	....
Ferric oxide and alumina	....	0·16	....	0·48	0·52	2
Sulphuric anhydride	46·56	46·96	58·16	46·68	43·32	14
Carbonic anhydride	tr.	....	....	tr.	9·36	16
Water, loss on ignition	20·80	20·65	1·55	20·75	1 70	8
Insoluble mineral matter	....	0·20	....	....	3·30	27
	100·16	100·69	100·51	100·51	100·40	100

No. I. From east side of tunnel in Cove quarry, Cheverie, snow-wh compact.

" II. From opposite side of same tunnel, much harder, but not hydrous.

" III. Anhydrite from base of Cove quarry, Cheverie.

" IV. Top rock from Cove quarry, Cheverie, soft, white, compact

" V. Rock associated with gypsum, Upper Head quarry at Chever

" VI. Dark carbonaceous rock, overlying gypsum at Cove quar Cheverie.

PLATE XIV.

The Cove quarry at Cheverie.

1289—p. 74.

Upper Head quarry at Cheverie.

FIG. 3.

SECTION OF BOREHOLE IN THE CHEVERIE GYPSIFEROUS AREA

From Geological Survey of Canada
Vol. XV. p. 161 A A.

No.	Thickness of Strata Feet	Section of borehole	Total depth bored Feet	Material Cut
1	20		20	Surface and drift
2	30		50	Dark gray shales
3	150		200	Shale and gypsum mixed in streaks
4	370		570	White gypsum
5	80		650	Red shale
6	10		660	Light-gray shales
7	240		900	Red. shale
8	100		1000	Red and gray shale in alternate layers
9	20		1020	Gray sandstone with a flow of salt water
10	200		1220	Light-gray shale, with a little sandstone
11	50		1270	Red and gray shales mixed
12	130		1400	Shales with gypsum
13	350		1750	Whitish quartzose sandstone, very gritty
14	60		1810	Dark-gray shale
15	30		1840	Dark-gray sandstone Flow of salt water { not so strong as the last
16	50		1890	Dark-gray shale
17	20		1910	Whitish-gray sandstone, with a great flow of salt water

The following is an analysis of the Cheverie brine:—

Specific gravity, at 15° C, 1·1387.

	Results by weight Per cent.
Calcium sulphate	0·3957550
Calcium chloride	0·5152726
Magnesium chloride	0·3261256
Ferrous carbonate	0·0027988
Sodium chloride	16·8279620
Total mineral matter	18·0679140
Water	81·9320860
Total	100·0000000

An Imperial gallon of this brine contains:—

	Grains.
Calcium sulphate	315·46433
Calcium chloride	410·74208
Magnesium chloride	259·96628
Ferrous carbonate	2·23704
Sodium chloride	13414·16587
Total mineral matter	14402·57560
Water	65310·97440
Total	79713·55

Sheet No. 45, Avon river, Hants county.

Total gypsiferous area, 70·56 square miles.

On both sides of the estuary of the Avon river extensive deposits of gypsum have been known since the early discovery of the country, and some of them were operated over a century ago. Beginning at Summerville, on the east side, and Mount Denson on the west side, and continuing up the river for a distance of 8 to 10 miles, or until it meets with the irruptive rocks of the Ardoise hills, is the width here of the lower Carboniferous measures in which the gypsum deposits occur. These measures, which extend eastwardly, and are described in the opening of this chapter, carry, almost without interruption, gypsum deposits as far as the Shubenacadie river.

Many of the operations of the past in this section have been, for various reasons, abandoned. Few have made any attempt to operate below drainage level, and water has driven them out. Many of these deposits have an overburden of clay, and owing to its increasing thickness, became too expensive to operate under existing circumstances; in others the prevalence of anhydrite has been discouraging, and concentration of trade has had much to do with closing out small operators; but not even in the quarries with the oldest history can it be said that the gypsum became exhausted.

Starting again at the northwest angle of this sheet, near Summerville, there is an area on the east side of the Avon, which by erosion of the river bank has been divided from the main body. It is known as Grant's quarry, and was operated for many years, but, although situated within a few hundred yards of the shipping pier, the rock dipping eastwardly under a heavy overburden of clay made operations too expensive, and the place has been abandoned. The rock here was a very fine white compact variety, showing a few streaks of black irregularly distributed through the white. The black was high in carbonate of magnesia, and carried some bitumen and iron pyrites.

A short distance above Summerville occurs the next outcrop, from which a small quantity has been taken. It has a small area, and is of little importance.

On the west side of the river, a few miles farther south, at Mount Denson, extensive cliffs 40 to 60 feet in height occur on the banks of the river and extend out on the beach to the river bottom. The greater part of the exposure here appears as anhydrite, but much of the concealed measures show evidence of a softer rock, and part of the rock on the beach is an excellent variety of gypsum, white, with a fine compact structure.

Prominent outcrops are also seen on the Scott estate and on the Hannah property, between the shore and the main road leading to Windsor. At the former place is one of the old quarries which was operated many years ago. It has a face exposed from 50 feet downwards, and much of it is white and blue gypsum, of a good variety, but associated with considerable anhydrite. On the Hannah property the principal outcrops are anhydrite. West of this property, about 1 mile from the shore, at the Duck pond, an extensive exposure is seen, from 40 to 60 feet in height. Much of the rock is harder than that allowed by the scale of hardness, yet in composition it is a true gypsum, white and compact. At Lower Falmouth there is a prominent exposure in the old quarry at Young's, and continuing on to Falmouth many outcrops occur. The most extensive is on the Glebe property, situated about 1½ miles from the western shores of the Avon river, opposite Windsor. Here the gypsum exposures have an average height above drainage level of 55 feet, and cover an area of several acres. Easy gradients could be secured from the deposit to the shipping point, and this, with a good white and grey compact rock showing but few irregularities, gives commercial value to the property. Continuing southwardly from the above, the outcrops are again met with on the Hanson property, but the gypsum, especially that occurring in lower ground, is irregular in colour and texture. This is another abandoned quarry.

The following analyses will show the general average composition of t[…] gypsum in the Mount Denson and Falmouth section:—

--	I	II	III	IV	V	VI	VII	VIII	IX
	%	%	%	%	%	%	%	%	
Lime	32·23	36·52	32·30	32·67	34·08	36·90	32·23	32·30	36
Magnesia	tr.	tr.	tr.	tr.	tr.	tr.	tr.	tr.	0
Ferric oxide and alumina	0·80	0·46	0·20	0·24	0·06	0·42	0·28	0·12	0
Sulphuric anhydride	45·92	52·32	46·68	44·64	43·62	52·80	45·27	46·58	41
Carbonic anhydride	0·56	0·59	0·15	1·87	2·11	0·51	0·86	0·08	4
Water, loss on ignition	20·55	10·20	20·70	20·15	19·55	8·95	20·33	20·65	18
Insoluble mineral matter	0·20	0·40	....	0·26	0·30	0·24	0·48	0·10	0
	100·26	100·49	100·03	99·83	99·72	99·82	99·45	99·83	102

No. I. White compact rock, from the Scott estate, Mount Denson.
" II. From Hugh Hannah property, at Duck pond, Mount Denso[…]
" III. Snow white, compact variety, from the shore below high wat[…] mark at Mount Denson.
" IV. Soft white rock from Young's old quarry, Lower Falmouth.
" V. Grey rock with snow-white streak, from Glebe propert[…] Falmouth.
" VI. White rock from H. Hannah property near the shore.
" VII. Snow-white compact variety, from upper quarry, on Hans[…] property, Falmouth.
" VIII. The best from Hanson lower quarry, Falmouth, uneven i[…] colour and texture.
" IX. Dirty greyish rock, from same location as No. 8.

Crossing the Avon river to Windsor on the east side we are on the his[…]toric ground of the gypsum industry of this Province. Here the gypsum bed[…] lie almost parallel, having a strike east and west, the northern and souther[…] boundaries converging slightly as they near the Kennetcook valley on the eas[…] The greatest distance across the strike is about 6 miles. The most souther[…] operations are those of the Wentworth Gypsum Company, at Meadow quarry[…] while the most northern are those of the Newport Plaster Mining and Develop[…]ment Co., Ltd., at Avondale.

Within the town of Windsor what was the most important deposit know[…] (now abandoned), is the old Pellow quarry. This is an excavation about 80[…] feet long, 150 feet wide, with an average depth below the street level of 40 feet[…] It has been estimated that about 500,000 tons have been exported from thi[…] quarry. It is now more a point of scientific interest than an economic propositio[…] The anhydrite occurs here in lenticular masses from 2 to 10 feet thick in th[…] centre, and from 50 to 75 feet long, embedded in the gypsum. Crude petroleum[…] has also been reported as occurring in large cells, in nodules of gypsum foun[…] in the clay which formed a covering to the deposit.

Meadow quarry, near Windsor, N.S.

2?? p. 78.

Quarry of the Windsor Gypsum Company, Newport, N.S.

One and a quarter miles south of Windsor there are what were known as the Wilkins and Redden quarries, long since closed, except for small quantities now being used for calcining purposes by the Windsor Plaster Company.

Beginning with the operations on the southern beds, the first is the Nova Scotia Gypsum Company quarry, at Threemile plains. This is situated about 3½ miles from Windsor, near the Dominion Atlantic Railway Company's line, on which the rock is transported to Windsor for export purposes. The rock is an excellent white, compact variety, having a working face 30 feet in height above drainage level; but it has a heavy overburden of clay, averaging 30 feet in thickness. This is considered the extreme limit of clay that can be moved profitably by the present methods of operating; that is, 1 foot of clay to 1 foot of face. An attempt was made to mine this rock, but sufficient height of face could not be secured without the use of pumps to make it an economic proposition.

South of this, about half a mile, is the Meadow quarry, owned and operated by the Wentworth Gypsum Company, and shown in Plate XVI. Here the rock has no covering of clay. The surface is very uneven, being covered with kettle, pipe, or blow holes, and as usual, where the gypsum is free from covering, the first few feet of the exposed surface is badly disintegrated by atmospheric action. On the eastern side of the quarry the face is 75 feet in height, extending westward and gradually diminishing in height; it also shows a natural water course or cave near the bottom. These beds are practically horizontal, and slightly stratified.

This quarry is connected with the Dominion Atlantic railway by a branch road about one mile in length. Shipments are made over it to Windsor (4 miles) in summer, and occasionally to Halifax (41 miles) in the winter season.

The next property, 1½ miles east of the above, is the quarry of the Windsor Gypsum Company at Newport (Plate XVII). The occurrence and the conditions under which it is operated are very similar to those of the Nova Scotia Gypsum Company above described, except that the operations are much more extensive. The superior quality of the rock in both these places is the only circumstance that makes it possible to operate under existing conditions. This property is also connected with the Dominion Atlantic railway, over which the crude rock is hauled to Windsor for water transportation to the United States.

A feature of considerable geological interest occurs here, which would warrant more complete investigation if time permitted. Within a distance of 2 miles, on the same strike and having a similar elevation above the sea-level, three exposures are seen. Two of these, one on either end, have been planed off by glacial action to practically an even surface, and covered with a heavy overburden of boulder clay, (compare Plates XVI and XVII), while the centre one is quite free from clay, and does not show the same glacial action, nor any overburden of clay.

East of this, at Newport, there are a few other deposits which in the past have been operated and are now closed, but they are of no particular importance, and so similar in quality to those described that it is not necessary to gi[illegible] a detailed description of each outcrop.

The following analyses will serve to show the composition of the rock fro[illegible] this section:—

—	I	II	III
	%	%	%
Lime	32·62	32·74	31 [illegible]
Magnesia	tr.	0·16	0·1[illegible]
Ferric oxide and alumina	0·86	0·32	0·2[illegible]
Sulphuric anhydride	46·06	45·68	45·1[illegible]
Carbonic anhydride	tr.	tr.	tr.
Water, loss on ignition	20·30	20·52	20·[illegible]
Insoluble mineral matter	0·14	0·52	2·3[illegible]
	99·98	99·94	99·[illegible]

No. I. White compact rock, from the Nova Scotia Gypsum Compan[illegible] quarry at Threemile plains.

No. II. Average sample from the Meadow quarry at Newport.

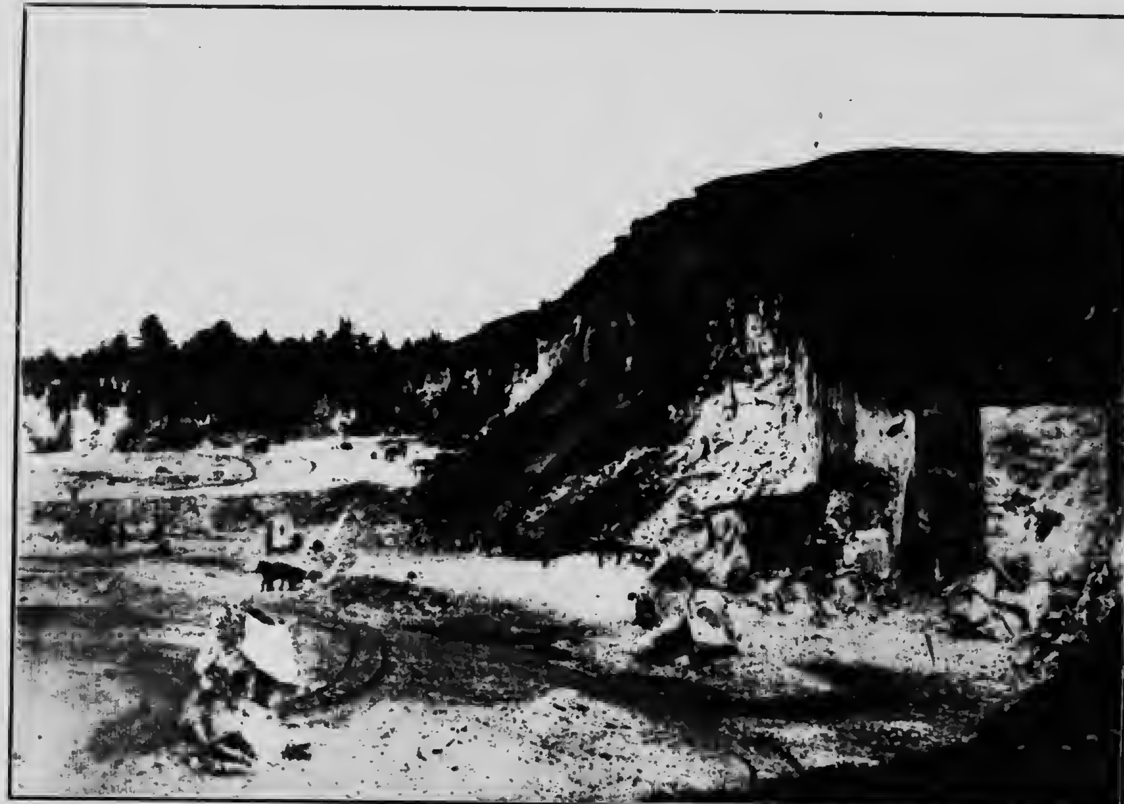
No. III. Bluish white compact. average sample from Wilkins quarr[illegible] Windsor.

North of the above described quarries, between 1 and 2 miles, occu[illegible] the second series of parallel gypsum beds. The principal operations are on th[illegible] Wentworth deposit, owned and operated by the Wentworth Gypsum Compan[illegible] From here the largest gypsum exporting business of the Province is carrie[illegible] on. This trade in 1868 amounted to 10,000 tons, while in 1909 it exceed[illegible] 175,000 tons. The deposits are very extensive, the Company owning about 1,2[illegible] acres, all underlaid with gypsum. The rock is principally a white compa[illegible] variety, well suited for all manufacturing purposes. Anhydrite occurs irreg[illegible]larly, in some parts in prominent exposures, in others beneath the floor of th[illegible] quarries. The operations are illustrated in Plates XVIII and XIX, and fro[illegible] them it will be seen that the greater part is covered by a heavy overburden [illegible] clay, in some places from 25 to 30 feet thick, but it has an advantage over th[illegible] southern deposits in having a higher working face beneath the clay.

In the past all this clay was brought down with the gypsum and remov[illegible] by horses and carts to the waste dump. At present the steam shovel is bei[illegible] used in some places to remove the clay from the top, before the rock is blaste[illegible]

These quarries are connected by a standard gauge steam railway with th[illegible] shipping piers, 2½ miles distant, on the St. Croix river, which is a tributary [illegible] the Avon.

After the rock is blasted and broken to one man size (meaning the size o[illegible] man can conveniently handle), it is put in carts and hauled to a loading sta[illegible] sufficiently high to dump directly into cars (Plate XX). It is then taken [illegible] train to the shipping pier and loaded into barges (Plate XXI) which are di[illegible]



Wentworth Gypsum Company's quarry, showing method of removing the clay.

Wentworth Gypsum Company's quarry : general view of quarry and transportation to pier.

Wentworth Gypsum Company's loading stage for cars.

Wentworth Gypsum Company. Loading gypsum into barges.

989—p. 80.

Wentworth Gypsum Company. Barges in tow.

mantled schooners of about 2,000 to 2,500 tons capacity, and towed to New York, generally three in a tow. These barges are usually taken out singly (Plate XXII), at high tide on the Avon, and anchored in head waters of the Minas basin, where the whole tow is made up and taken by an ocean going tug. The whole product of these quarries is taken exclusively by Messrs. J. B. King and Company, who have extensive mills on Staten island. This firm is also a large holder in the Wentworth Gypsum Company.

East of the Wentworth Gypsum Company property, a ' adjoining it, is the Phillips farm. It has an area of 75 acres, and an average elevation above drainage level of 60 feet. It was tested in 1909 by a series of trenches and pits, and showed an excellent variety of white and snow-white gypsum of fine compact structure, the greater part being covered with clay; showing in the pits and trenches from 2 to 15 feet deep.

The proposed shipping point for this deposit is on the St. Croix river, above the railway bridge. This bridge is fitted with a draw having a width of 32 feet.

Above the St. Croix public bridge and east of the last described property, high prominent cliffs of gypsum and anhydrite are seen, and from here back to Newport station occurs an almost continuous series of outcrops, but the greater part of them show anhydrite in abundance. Above the St. Croix bridge, 30 or 40 years ago, gypsum was quarried and scowed down the river for export purposes.

Again, farther east on the Meander river, gypsum was quarried on the Woolaver property, and on the Chambers property. On the latter, prominent exposures are now seen of white and blue gypsum, of both granular and compact texture. The operations were carried on here many years ago, when the transportation was done in small vessels which loaded near the old shipyard.

Going north from the Wentworth quarries to the third range of gypsum beds, the principal operations are carried on at Avondale by the Newport Plaster Mining and Development Company, Ltd. (Messrs. J. B. King & Co., of New York, being the principal holders). This Company controls about 4,000 acres of gypsum land in this vicinity, and is preparing for extensive operations. The old quarry, which was operated here some years ago, has been reopened at a lower level, by driving a tunnel large enough for drainage and railway track. This will lower the floor of the quarry from 10 to 20 feet. They also extended their operations west about 2½ miles, where they are opening up a new quarry, and connecting it with their shipping pier by a standard gauge railway, now under construction.

The rock is principally white in colour, with some little grey and black. Portions of it show an excess of carbonate of lime.

On the eastern extremity of this Company's property are the old quarries at Miller creek, which were abandoned many years ago, but likely to be reopened by this Company.

Continuing east , prominent exposures occur on the west sid River Hebert, ne. . . e railway, and on the Chambers property on the side. Here considerable anhydrite is in evidence, but some very superior sr white gypsum is seen on the Chambers properties.

The exposures at this latter point are low, but the rising ground going gives evidence of large quantities covered with clay.

The following analyses will show the composition of the principal exposures in this section:—

—	I	II	III	IV	V	VI	VII	VIII
	%	%	%	%	%	%	%	%
Lime	32·42	32·98	35·39	17·63	32·46	32·86	31·92	32·55
Magnesia	....	......	1·30	1·40	0·76	....	......	....
Ferric oxide and alumina	0·20	0·46	1·28	4·58	0·26	0·46	0·56	0·30
Sulphuric anhydride	46·12	45·11	32·47	25·44	43·48	46·60	46·56	46·28
Carbonic anhydride	0·83	0·74	11·10	....	2·01	0·83	......	1·61
Water, loss on ignition	20·60	20·30	13·67	12·75	10·95	20·55	20·75	20·32
Insoluble mineral matter	0·32	0·60	4·30	38·20	1·10	....	0·32	0·88
	100·49	100·19	99·51	100·00	100·02	100·47	100·11	100·53

No. I. Average sample from the Wentworth Gypsum Company's Eagle Swamp quarry.

" II. Average sample from the Wentworth Gypsum Company's stock pile at Wentworth.

" III. A dark greyish rock associated with gypsum at the Wentworth quarries.

" IV. Dark shaly pinkish material occurring on the north side of railway, about 100 yards east of Dimock station.

" V. From deposit south side of railway, east of No. 4, soft mixture of dark greyish blue and white.

" VI. Snow white nodule taken from test pit north side of hill on Phillips farm.

" VII. Taken from bottom of a blow hole about 40 feet deep, at the base of the hill, Phillips farm. The sample was hard enough to give a metallic ring when hit with hammer.

" VIII. From a test pit near the north boundary, white compact variety.

Besides the above described properties there are many other deposits of prominence in this section, as those farther south on the St. Croix river, in McKay settlement, and on the Kennetcook river, which are at present inaccessible to transportation facilities, and do not differ materially from many already described, and, therefore, will not be given here in detail.

Sheet No. 46, Clarksville, Hants county.

The continuation northeastwardly of the Avon sheet is an area consisting of 19·44 square miles, which will be known as the Clarksville.

This area is in the valley of the Kennetcook river, through which the Dominion Atlantic railway (Midland division) passes. At this point, the gypsiferous area seems to form the lower members of the lower Carboniferous group, and the principal outcrops are near its contact with the older rocks, and under present conditions have not sufficient prominence to be considered commercially valuable for anything beyond the local demand.

Sheet No. 47, Ninemile river, Hants county.

This is a small gypsiferous area, consisting of 9·37 square miles, situated east and adjoining sheet No. 48, and altogether it contains many prominent deposits of good gypsum. It is so far from transportation facilities that it may be considered inaccessible for everything except local uses.

GYPSUM DISTRICT 'F.'

Sheet No. 32, Malagash, Cumberland county.

Near the eastern extremity of the Clairmont anticline is a gypsiferous area of 2·19 square miles. In this several important outcrops of gypsum occur. On the shore of Plaster cove, East Wallace, on the road leading to Wallace and eastwardly to North Shore, Malagash, the beds can be followed almost continuously, associated with greenish yellow marls, clay, and limestone. The rock is white, with compact crystallization. The location of these deposits, so easily accessible to water transportation by the Gulf of St. Lawrence, and having the Pictou coal fields on the east, and the Cumberland coal field, 35 miles distant by rail, on the west, makes it one of the most desirable in the district for supplying the Canadian markets, either with the crude or manufactured article.

Sheet No. 33, Pugwash, Cumberland county.

Following the Clairmont anticline westwardly we again have important outcrops of gypsum near Hartford, associated with the limestones; at Canfield creek, a tributary to the Pugwash river, and 4 miles from its mouth; and also—principally in concealed measures—on the east and west side of the Pugwash River basin, and on Victoria island in the basin. This whole basin evidently was at one time a calcareous formation.

The most interesting part of this section is that of Canfield creek. Here the grey, greyish white, and white gypsum outcrop in extensive beds. They are within 2½ miles of railway, and if connected, it would place them within 5 miles of deep water shipping.

At the northern base of the gypsum outcrops, in a shallow basin of water, at the water's edge, the largest and purest deposit of selenite known has been discovered.

Analyses of the samples taken from Canfield creek show the following results:—

—	I	II
	%	%
Lime	33·25	32·86
Ferric oxide and alumina	0·74	0·40
Sulphuric anhydride	42·76	45·52
Carbonic anhydride	3·11	1·24
Water, loss on ignition	19·30	20·50
Insoluble mineral matter	1·72	0·40
	100·88	100·92

No. I. Sample from old quarry, greyish white in colour and slaty structure. This rock is being used in the manufacture of fertilizer at Pugwash.

" II. White, with compact crystallization.

Sheet No. 34, Philip river, Cumberland county.

On this sheet is shown the gypsiferous area of the Clairmont anticline, continuing westwardly from sheet No. 33, and it still continues westwardly in almost a straight line—but not of equal importance—to Salt Springs and Clairmont Hill to within a few miles of Springhill mines.

The gypsum outcrops at Hansford, on Thompson road, and near Hansford siding. It consists principally of a blue and bluish white rock, with granular texture in prominence. This has an average of 1·83 square miles. North of this about 2½ miles near Roslin, on Philip river, is an isolated area consisting of 697 acres. It has prominent outcrops, on Plaster creek, and at Jasper Rushton's. Here the rock is a white compact variety. Again, east of this, near Oxford town, at a point known as Salt lake, in a similar area, prominent outcrops are observed. From this place small quantities are quarried and brought to the lower end of the lake, about 1½ miles, where it is ground for loc. purposes.

The following analyses will serve to show the qualtiy of this rock:—

—	I	II	III
	%	%	%
Lime	33·69	32·86	32·55
Magnesia		....	tr.
Ferric oxide and alumina	0·40	0·50	0·50
Sulphuric anhydride	44·40	45·86	44·12
Carbonic anhydride	2·35	0·93	2·92
Water	20·37	20·47	20·45
Insoluble mineral matter	0·40	0·12	0·20
	101·61	100·74	100·78

No. I. White, compact rock, from Salt lake.
" II. Bluish-white, granular, from Lockhart quarry.
" III. White, compact variety, from Thompson road.

Sheet No. 35, Springhill mines, Cumberland county.

East of the Springhill coal mines about 2 miles, and at the western extremity of the Clairmont anticline, occurs a small gypsiferous area of 771 acres. It consists principally of concealed measures, and can be traced by mounds and sink holes. In the south branch of Black brook the gypsum is seen in beds associated with blue and yellowish marls and shales. The only importance attached to this is its close proximity to the coal mines, for manufacturi.g purposes.

Two miles east of Springhill junction, occurs a similar area of 620 acres. It is bounded on three sides by faults, and, therefore, shows much disturbance. In a small brook, running through Stewart's meadow, the gypsum is seen associated with red and greyish marls. This, like that at Springhill mines, may be of some economic value for manufacturing purposes, but only by mining or quarrying below the drainage level.

Reviewing this whole division 'F' (exclusive of sheet No. 37, Parrsboro), there is not much doubt that this gypsiferous area is much greater than that shown on the maps; and that it extends the whole length of the Clairmont anticline from North Shore, Malagash on the east, through Hartford and Hansford, to Clairmont, and terminating against the coal measures of Springhill mines; and that Nappan and Philip river form a northern boundary to the Cumberland coal fields, continuing westwardly to Minudie, across the Maringouin peninsula into the Hillsborough gypsum field of New Brunswick.

Not much energy has been shown in the development of this area, and although much of the gypsum is concealed beneath an overburden of clay, there is strong evidence that if systematically tested, it would show much very superior rock that would warrant the establishment of important industries.

Sheet No. 36, Nappan, Cumberland county.

About 1 mile north of Nappan station, and extending westwardly to Cumberland basin, occur outcrops of importance, in a gypsiferous area traceable over 800 acres. The topography of the country is low, consisting principally of marsh or dike lands, which makes it difficult to trace boundaries. The exposures are known as the Newcombe, the Fowler, and those operated by the Maritime Gypsum Company, Limited, which cover an area of 12 acres. This Company has been operating for several years, shipping an average of 4,000 tons per year. Their operations have been carried on below the drainage level, in an open pit to a depth of 50 feet below the fractured surface, and they have tested the ground by bore holes to a depth of 100 feet. During the summer of 1909 they installed a Ledgerwood cable system, and are prepared to sink to a further depth. This property is connected with the Intercolonial railway by a branch line, which also conne[illegible] [illegible]th their shipping pier, at tidewater, on the Cumberland basin, 2½ miles fr[illegible] [illegible]uarry.

The rock at the surface is [illegible]rably fractured, and is mixed somewhat with clay and thin seams of dark carbonaceous material, but at depth it is white, compact, and very pure.

The follow[illegible]g analyses will serve to show the average composition of the different expo[illegible]ures in this section:—

——	I	II	III	IV	V
	%	%	%	%	%
Lime	44·40	32 36	32 42	32·23	31·54
Magnesia	tr.	....	....	....	....
Ferric oxide and alumina	2·70	0 64	0·10	0·15	0·84
Sulphuric anhydride	6·92	44·32	46·72	46 56	44·20
Carbonic anhydride	32·22	2·42	....	....	0·35
Water, loss on ignition	3·35	19·90	20·80	20·80	19·75
Insoluble mineral matter	10·20	0·40	....	....	3·80
	99·79	100·04	100·04	99 75	100·48

No. I. From the old Fowler quarry, principally carbonate of lime.
" II. From the Newcombe deposit, dark dirty grey, granular cry-tallization.
" III. From property of the Maritime Gypsum Company, Nappa snow-white compact variety, occurring in nodules.
" IV. From property of the Maritime Gypsum Company, their bes variety slightly resembling white alabaster.
" V. From the property of the Maritime Gypsum Company, dirt red colour, mixed with small veins of clay throughout.

Sheet No. 37, Parrsboro, Cumberland county.

On this sheet two small patches of gypsiferous ground occur, the first abou 2 miles east of Parrsboro, the other at Clarks head, about 4 miles east of Parr-boro.

On the shore at the latter place it occurs in contact with the igneous rock in thin layers or veins, pink, black, white, and grey, associated with heavy bed of marl.

About one-quarter of a mile inland the occurrence has much more promi-nence, and at one time quite extensive operations were carried on, and the pro-ducts exported to the United States. At this quarry the rock is a white com-pact variety, showing some little anhydrite.

The following analyses are the result of samples taken from this section:—

—	I	II	III
	%	%	%
Lime	32·80	32·95	32·4
Magnesia	0·70	trace.	....
Ferric oxide and alumina	0·40	0·58	0·4
Sulphuric anhydride	44·28	44·03	46·5
Carbonic anhydride	1·91	2·46	..
Water, loss on ignition	19·72	20·00	20·8
Insoluble mineral matter	0·40	....	0·2
	100·01	100·02	100·3

No. I. Sample from the shore at Clarks head, soft white, with gre spots, semi-granular.
" II. Sample from old quarry, bluish-white, compact.
" III. Sample from pink vein in the marl on shore.

OTHER DEPOSITS.

There are a few smaller deposits, in addition to the above described, occur-ring in Nova Scotia. They may be enumerated as follows:—

Deposit in Colchester county.—In a small lower Carboniferous area pro-truding through the Triassic sandstones on the Lynds property, at Debert, i an occurrence of a thin band of impure gypsum, associated with carbonate of lime. It is a dirty greyish colour, and has the following composition:—

	Per cent.
Lime	36·15
Magnesia	1·35
Ferric oxide and alumina	0·56
Sulphuric anhydride	22·60
Carbonic anhydride	18·67
Water, loss on ignition	11·10
Insoluble mineral matter	9·52
	99·95

West Advocate, Cumberland county.—Here, on the north shore of the Bay of Fundy, occurs an outcropping of gypsum below the high water mark.

Blomidon, Kings county.—In the marly beds that overlie the conglomerates near Pereau, and extending to Blomidon, occur many veins of selenite and fibrous gypsum, usually less than one foot in thickness and often coloured.

Indian point, Mahone bay, Lunenburg county.—At this point is a gypsiferous area of about one square mile, of the Windsor series. Gypsum is indicated by funnel-shaped depressions extending for over 3,000 feet across the area, and forming the road bed for the Halifax and Southwestern railway. It is possible that this deposit may develop a proposition of commercial value, as the natural facilities are good, and near both home and foreign markets.

CHAPTER V.

Gypsum Deposits of New Brunswick and Magdalen Islands.

GYPSUM DEPOSITS OF NEW BRUNSWICK.

The occurrence of gypsum in New Brunswick, like that in Nova Scotia, in the lower Carboniferous measures, and Dr. L. W. Bailey, in the Mineral R sources of New Brunswick, says: 'They usually occupy a position at or ne the summit of the group, and are genenerally in close connexion with beds limestone, from which, in part at least, they may have been derived by alter tion.' But Dawson, in Acadian Geology, says: 'They occur in all parts of t lower Carboniferous.' With which view the writer concurs.

The principal deposits are seen in southern New Brunswick, in the counti of Kings, Albert, and Westmorland. In Kings, prominent outcrops are seen the vicinity of Sussex and Upham; in Albert, near Hillsborough, Hopewell hi and Demoiselle creek; and in Westmorland at Cape Meranguin and in t vicinity of Petitcodiac. In the northern part of New Brunswick gypsum is on known to occur at Plaster rock, on the Tobique river, Victoria county.

Again, like those of Nova Scotia, the deposits here present every variety colour and texture, yet a much greater quantity of that white clear transluce variety known as alabaster exists, and it has been extensively operated in th vicinity of Hillsborough.

An index map, and several sheets showing the location of the different d posits of New Brunswick, have been prepared to accompany this work, and wit the following descriptions an attempt will be made to show as nearly as possib from superficial examination, the true value of each deposit, hoping that it wi prove of value in the development of this important industry.

Sheet No. 1, Plaster rock, Victoria county.

In the lower Carboniferous measures of the Tobique valley very prominen and extensive deposits of impure gypsum occur in the cliffs of the Tobique rive and its tributary, the Wapskehegan.

These cliffs are very conspicuous in the bank of the Tobique, often risin 125 feet or more above the river bed. The impure gypsum occurs in practicall horizontal beds, often instratified with thin veins of pure, white, compact gyp sum, with smaller quantities of selenite and fibrous varieties.

In colour it is reddish, sometimes mottled with grey, resembling somewha the Triassic sandstone, and is coarsely granular in texture. It is unfit for th manufacture of the many products to which the other deposits of New Brun wick and Nova Scotia are so well adapted, but it is highly valued as a minera fertilizer, and will be referred to in another chapter.

In the past, for many years considerable quantities of this rock have been removed and taken to Aroostook county in Maine, and used extensively in the cultivation of potatoes; and small quantities have also been used to advantage in the St. John River valley.

At present this deposit, having connexion with the Canadian Pacific railway, is operated by Messrs. Donald Fraser and Sons, and the product taken to Montreal by rail for use in the manufacture of cement.

The following analyses of the rock will serve to show its average composition:—

—	I	II
	%	%
Lime	27·92	28·95
Magnesia	1·96	tr.
Ferric oxide and alumina	2·72	9·80
Sulphuric anhydride	38·21	41·06
Carbonic anhydride	2·39	0·58
Water, loss on ignition	17·80	18·45
Insoluble mineral matter	8·86	1·18
	99·86	100·00

No. I. Sample of reddish grey rock, from face on Tobique river.
" II. Sample resembling Triassic sandstone, from top of deposit on Fraser's farm.

Sheet No. 2, St. Martins, Kings, and St. John counties.

This sheet, which covers a large tract of country, is made particularly to show the location of the Hammond River gypsum deposits with reference to the St. Martins railway, which connects Quaco harbour, on the Bay of Fundy, with the Intercolonial railway at Hampton (distance 28 miles). They also cover a small area at Martins head.

The Hammond River gypsiferous area, consisting of 250 acres, although it is reported that a few hundred tons have been removed, has never been systematically operated, or even prospected, yet there is much evidence of a deposit of commercial importance.

The location of this area is in Upham parish, and crosses the railway about 11 miles from the Bay of Fundy terminus at Quaco. An outcrop of a very excellent snow-white gypsum occurs on the Hammond river, about one mile below the railway bridge. Other outcrops are observed at points 1½ and 2½ miles eastwardly from the railway. These are much more prominent exposures, and show white, compact gypsum, somewhat varied with the selenitic varieties.

If, on testing, this property should prove as good as the surface indicates, being so easily accessible to railway and comparatively near a shipping port, it would be a desirable location for a manufacturing industry for supplying either the home or foreign market.

The following analyses show the composition of average samples taken f this area:—

—	I	II
	%	c
Lime	32·40	3:
Magnesia	tr.	tr
Ferric oxide and alumina	0·10	(
Sulphuric anhydride	46·12	4(
Carbonic anhydride	0·75	....
Water, loss on ignition	20·40	2(
Insoluble mineral matter	0·06	(
	99·93	10(

No. I. Snow-white, from Hammond River outcrop, near Upham.
" II. White, 2½ miles from Hammond River outcrop.

This sheet also shows a small isolated gypsiferous area, consisting of acres situated at Martins head, on the Bay of Fundy coast, 21 miles northe from Quaco. Here the gypsum shows much disturbance, and is in close cont with the older Pre-Cambrian rocks.

The outcrops are greyish-white in colour, and have associated with th heavy beds of marl, which carry veins of fibrous gypsum and irregular mas of much contorted gypsum; and although at tide waters, it is on an expo coast, where it is difficult to provide protection for shipping, it cannot be c sidered of much commercial value.

Sheet No. 3, Sussex Valley, Kings and Westmorland counties.

On this sheet are shown four gypsiferous areas, known as Apohaqui, c sisting of 313 acres; Mount Pisgah, 678·4 acres; Smith creek, 320 acres; a Petitcodiac, 454 acres. A great part of some of these areas is in low grou

Beginning at the west, the Apohaqui area is the most important. The lo tion is on high ground and the opportunities for development are good. On t farm of Col. Campbell prominent outcrops of gypsum occur, from 20 to 40 f high. It is white and very compact, having the appearance of anhydrite some points, but by analyses shows the requisite amount of water, and suita for all ordinary manufacturing requirements.

About 4 miles east of Sussex station, in the valley of Smith creek, oth outcrops occur, but the greater part of the exposures are in low land, and sh much anhydrite.

Again, on the east and skirting the Piccadilly mountains, considerab prominence is shown in pits and mounds, with a few exposures which are pri cipally anhydrite.

The Petitcodiac area is situated about 2½ miles northwest of Petitcodi station (I. C. R.). where the outcrops occur on Fawcetts brook and may followed for about one mile. The gypsum is greyish-white in colour, and granular in texture. Much coarse selenite is mixed and associated with the gypsum in veins. For this reason the rock is not considered desirable for calcining, but is suitable for fertilizer or land plaster.

The following are the results of analyses from gypsum samples taken from the different deposits, as indicated below:—

—	I	II	III	IV
	%	%	%	%
Lime	32·86	32·16	31·98	32·48
Magnesia	.....	tr.	tr.	tr.
Ferric oxide and alumina	0·24	0·03	0·23	0·14
Sulphuric anhydride	46·00	46·27	45·21	46·55
Carbonic anhydride	0·77	.....	0·57	.....
Water, loss on ignition	19·63	20·75	20·50	20·48
Insoluble mineral matter	0·34	0·46	1·20	0·32
	99·84	99·67	99·69	99·97

No. I. From Piccadilly: hard bluish rock with every appearance of anhydrite.

" II. From Mount Pisgah: closely associated with anhydrite.

" III. From Col. Campbell's: white, very compact.

" IV. From Petitcodiac: greyish-white, granular.

Sheet No. 4, Hillsborough, Albert, and Westmorland counties.

At this place we reach the historic point of the gypsum industry of New Brunswick. Here for nearly a century the business of manufacturing and exporting the crude rock has been carried on under efficient management and with the most modern equipment of any place within the territory under consideration. This has had much to do with making it one of the leading industries in the Province.

In this part of New Brunswick the deposits of gypsum are more extensive and prominent than at any of the other points. They may be divided and known as Hillsborough, Demoiselle brook, Hopewell, and the Little Ridge deposits, running northwardly from Cape Enrage, in Albert county, and the Cape Maringouin area on the eastern side of Shepody bay. Of the Albert county deposits, those of the greatest purity are those operated at Hillsborough and Demoiselle brook, consisting of a total area of 14 square miles. These gypsum deposits, and their operation, while of great economic importance, present favourable opportunities for studying the many interesting geological problems connected with their formation. The great variety and occurrence of both gypsum and anhydrite having various colours and textures, generally white and firmly compact, but sometimes grey, pink, and selenitic, occurring closely associated with anhydrite, gives much food for thought.

The rock is usually massive—although much of it has a stratified app ance, lying in horizontal beds of various thickness—showing little disturba Although the greater part of the rock is white and compact, in places where gypsum is covered with an overburden of clay, a grey granular, often sele variety occurs near the surface, sometimes intermixed with selenitic cryst a sample of such is shown in Plate V. Again, very occasionally veins o cutting through the strata, having a folded or crumpled ribbon-like struct as shown in Plate XXIII.

Dr. Bailey[1], who has made a special study of these deposits, gives the fol ing description: 'At several points on the northern edge of the outcrops siderable quantities of gypsum are found, being snow-white in colour, and v ing in molecular structure, some of it being of exceedingly fine grain, and s quite coarse and sufficiently soft to be crushed between the fingers, with in mediate grades of fineness, but all grades equal in purity and colour.

'This part of the deposit is in masses, and not any in regular seams. W the pure white stone are intermixed veins of discoloured gypsum, of all sh of red, grey, and blue-grey. Most of these discoloured masses contain mor less grit, and when subjected to hydrochloric acid effervesce and show dence of the presence of carbonate of lime. Occasionally seams of red m like stone fill the space between the seams and fissures in the gypsum. Th are rarely in horizontal positions, but as a rule cut the face at varying an and occasionally are nearly perpendicular. This marl-like substance also tains carbonate of lime. Underlying the beds of pure white and mixed st as above described, masses of anhydrite are found; sometimes in thin la only, and at other times in beds of such thickness that attempts to penet them have been given up as unprofitable, and work has been pursued elsewh Immediately under the white stone, and running into it without any percept break, are generally found beds of pure anhydrite, which at this time have commercial value.

'Indications of pure, white stone, of this character, are visible at m points along the northern edge of the gypsum deposit, for a distance of ab three-quarters of a mile. The surface indications of this gypsum belt ext in width for about half a mile, the belt running in a northeasterly and so westerly course, the southern edge rising somewhat abruptly against a v steep hillside which is supposed to consist largely of a reddish conglomer that apparently forms the south wall against which the gypsum rests. S higher up on the hillside, and on the summit, freestone boulders are seen, an short distance below the summit a clean break and opening exposing the f stone is quite conspicuous. At this point, several natural trenches, paralle each other, with walls of freestone, and about 20 or 30 feet apart. exposed for a distance of several hundred yards, strongly suggesting the e tence of a series of faults or downthrows. Thus, the gypsum area would s to be bounded on two sides by marked dislocations converging westward at

[1] Mineral Resources of the Province of New Brunswick, p. 90.

PLATE XXIII.

Folded or crumpled ribbon-like structure of gypsum.

angle of about 45°. Between the northerly and southerly edges of the gypsum formation are several small valleys, evidently the work of brooks which have cut their way through the gypsum and have created at some points small bays or openings that have caught and retained alluvial deposits, producing meadows or intervals, which are exceedingly fertile. At many points the gypsum has entirely disappeared, leaving only the anhydrite exposed. The main brook on the northerly side rises apparently at the west end of the gypsum deposit, and flows in an easterly direction, until it falls over a limestone bed, with a descent of about 8 feet, and at this point the conglomerate rock upon which the limestone rests is exposed, dipping towards the northwest at an angle of about 20 degrees, and rising rapidly to the south until it reaches the top of a hill about three-quarters of a mile distant, at an elevation of about 150 feet. At this point the limestone is exposed and plainly seen on the surface. It then dips slightly to the south, and again underlies a gypsum formation of from 50 to 60 feet in height. The conglomerate rock is also to be seen a little farther to the westward, on the slope of the hill as it descends towards the river. This exposed body of gypsum is very much broken and discoloured, and of so little value that, though much nearer a convenient point for shipment than the main quarries now in operation, it is not at present worked and is not considered a profitable field from which to draw a supply. Following the main brook already referred to, in a westerly direction, the wall of anhydrite extends the whole length of the gypsum deposit, though not unbroken.'

Several quarries have been opened and operated in this section by the Albert Manufacturing Company, some of which are illustrated in Plates XXIV and XXV, and much underground work is being carried on. The working face of these quarries varies from 25 or 30 feet to over 100 feet, and some parts are covered with a heavy overburden of clay, while others are quite free from it. Where the surface of the gypsum is free from clay covering, it is very uneven and full of depressions and blow holes, which extend downwards many feet. In some of the quarry faces anhydrite occurs in veins or bands, cutting across and through the quarry in very irregular forms, at times destroying the whole value of the quarry, but in some cases it has been worked through and the quarry redeemed. This is also true of the underground workings, where large rooms 40 feet or more in height have been worked out, usually having a floor of anhydrite. Attempts have been made to test the depth of this floor, but so far no satisfactory results have been obtained.

The Albert Manufacturing Company—as before mentioned—has been operating at this point more or less extensively for years, and has shipped its crude product, with few exceptions, to the Calvin Tomkins Company in New York. The quarries are connected by railway with the Company's shipping pier, and transportation to New York is usually done with steamers, which load only when the tide is out. (See Plate XXVI.)

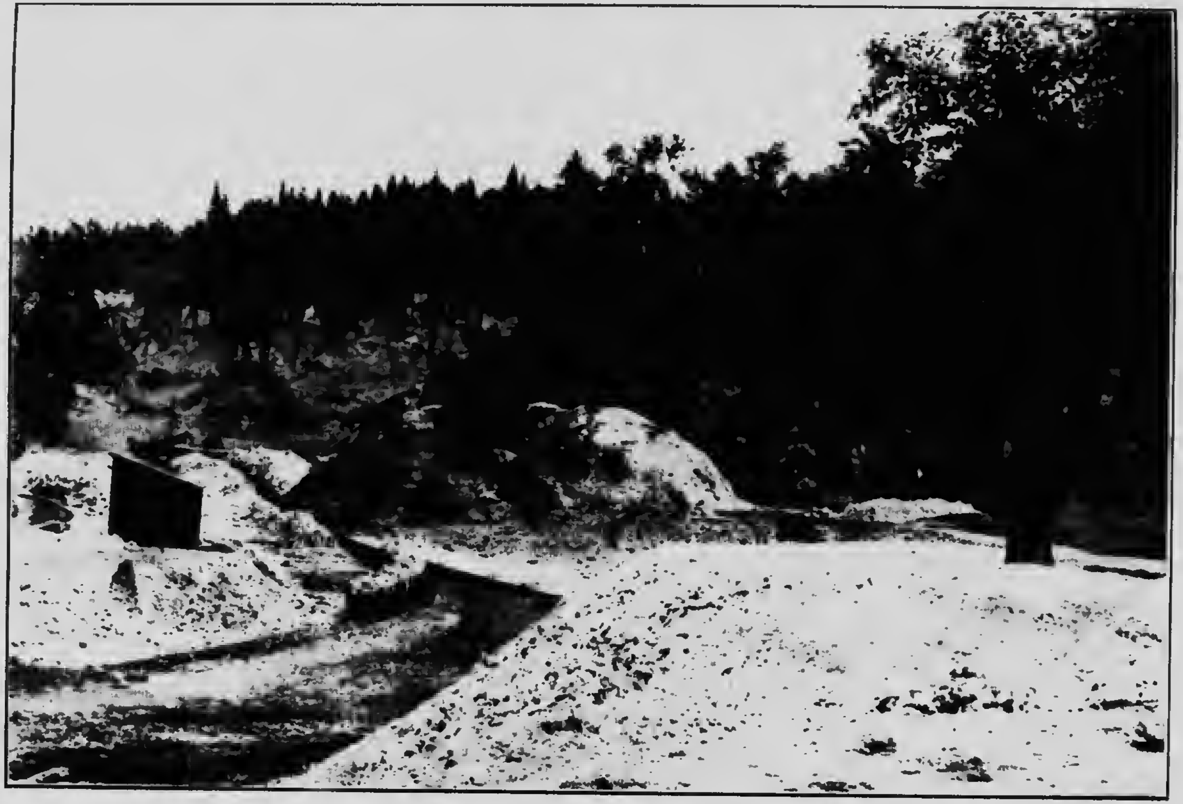
On the southern end of this area, at Demoiselle brook, the Wentworth Gypsum Company has been operating for a few years in a small way.

For about 15 years this Company has quarried from the surface, and shipp annually about 5,000 tons. Very similar conditions to those at Hillsborou were found; with perhaps the anhydrite more prevalent, hence the quarr were abandoned. In the latter part of 1908 this Company started undergrou operations, and was successful in developing an excellent deposit of snow-whi finely compact variety of gypsum.

From these underground workings the Company had mined at the end 1909, 7,000 tons, which has been hauled over the Harvey and Salisbury railw to a shipping point at Hillsborough, a distance of 8 miles, whence it is forwar to J. B. King and Company, at New York.

Sixteen miles south from Hillsborough, and about 2 miles west from shore of Shepody bay, the next gypsiferous area occurs—known as Hopew hill. The area contains 7·5 square miles, but principally concealed measu The southern boundary is the Shepody river, and no further indications seen, going south, until New Horton is reached, 28 miles south of Hillsborou where a narrow gypsiferous area occurs, extending to the shore at Cape Enra but here, like at Hopewell hill, few outcrops occur, and the measures are o traceable by surface indications.

In Westmoreland county, on the peninsula which divides Shepody bay fr Cumberland basin and terminates in Cape Maringouin, occurs a gypsifer area of 3·14 square miles. The gypsum occurs at Pink rock on the w side of the peninsula, and has a variety of colours, as white, grey, a pink, outcropping on the beach. It is both granular and compact in textu and associated with it is seen lenticular masses of anhydrite, in some cases o part of the original mass being intact, thus giving it the appearance of a wed This deposit is controlled by a company subsidiary to the Albert Manufacturi Company, that has operated to a small extent; shipping the product to United States.



Gypsum quarry of Albert Manufacturing Company, Hillsborough. N.B

289 p. 96,

Gypsum quarry of Albert Manufacturing Company, Hillsborough, N.B.

SS. *Nanna* loading at low tide: Albert Manufacturing Company, Hillsborough, N.B.

PLATE XXVII.

Workmen with tools in Gray quarry, Hillsborough, N.B.

The following analyses of samples from points indicated will serve to show the general average of the gypsum in this district:—

—	I	II	III	IV	V	VI	VII	VIII	IX	X
	%	%	%	%	%	%	%	%	%	%
Lime	32·92	32·72	33·28	33·00	33·00	32·60	33·00	32·92	32·04	36·69
Magnesia	......	......	......	......	......	......	......	......	tr.	......
Ferric oxide and alumina	0·60	1·80	......	0·40	......	tr.	......	......	0·18	0·18
Sulphuric anhydride	46·36	45·24	46·36	46·32	46·80	46·60	46·64	46·40	46·30	49·73
Carbonic anhydride	tr.	tr.	tr.	......	......	......	......	......	0·64	1·52
Water, loss on ignition	19·55	20·17	20·65	20·45	20·80	20·90	20·99	20·72	20·40	12·15
Insoluble mineral matter	0·40	0·80	tr.	......	tr.	......	......	......	......	tr.
	99·83	100·73	100·29	100·17	100·60	100·10	100·54	100·04	99·56	100·27

No. I. A very fine compact rock, dull white in colour, from the Albert Manufacturing Company, Hillsborough.
" II. A grey compact variety, from the same location as No. 1.
" III. Rock containing crystals of selenite, as shown in Fig. 6, colour white, compact texture, from Hillsborough quarries.
" IV. Sample of banded dark grey and white gypsum, from Hillsborough quarries.
" V. Ordinary white rock, from Hillsborough quarries.
" VI. White alabaster, from Hillsborough quarries.
" VII. Pink alabaster, from Hillsborough quarries.
" VIII. Manufactured terra alba, from the Albert Manufacturing Company's mill at Hillsborough.
" IX. From Wentworth Gypsum Company's underground quarry at Hillsborough, snow-white, compact variety.
" X. Location same as No. 9, and similar in colour and texture.

GYPSUM DEPOSITS OF THE MAGDALEN ISLANDS.

Before entering on a particular description of the gypsum deposits, it is considered advisable to give a general description of the whole group as shown on the accompanying map.

Situation.—The Magdalen islands are situated about the middle of the Gulf of St. Lawrence, and are within the parallels of 47 degrees and 30 minutes and 47 degrees and 5 minutes north latitude, and between 61 degrees and minutes and 62 degrees and 12 minutes west longitude, and at a distance of about 150 miles from the coast of Gaspe; 60 miles from Meat cove, Cape Breton, where they are connected by submarine cable with the mainland; and 120 miles from Pictou, Nova Scotia, from which port the mail steamer makes connexions twice each week during the open season on the Gulf of St. Lawrence.

Description.—There are ten distinct islands in the group, designated on all charts, and in public documents, under the names of Entry, Amherst, Deadman, Grindstone, Alright, Wolfe, Grosse Isle, Coffin, and Brion, and the grant also included the Bird islands. Four of these, namely, Entry, Deadman, Brion, and the Bird islands, are isolated, having no connexion with each other, or with the principal group. The other six islands, namely, Grosse Isle, Coffin, Alright, Wolfe, Grindstone, and Amherst, comprised in the Letters Patent under the collective name of Magdalen islands, are united to each other by sand dunes, and in some places lagoons of considerable extent are formed by the sand dunes.

Harbours.—The principal harbours are Amherst, House harbour, and Grand Entry.

The steamer also calls at the breakwaters at Amherst and Grindstone, and the landing places at Alright island, Coffin island, and Etang du Nord.

By reference to the Admiralty Chart of these islands, it will be seen that these harbours are safe and sufficient for small draft vessels, and the recent addition to the breakwaters gives ample protection to all ordinary shipping.

Topography.—The low lands, which border the sea coast, present a uniform appearance, generally undulating or level. The centre of the islands is made up of numerous conical shaped hills, some as high as 580 feet above sea-level.

No rocks are observed protruding through the soil, which extends from the highest to the lowest levels, and every foot of land is available for cultivation, except a small part of the low lands, which are occupied by swamp.

These islands are not the barren, isolated spots conceived by some; but on the contrary, the best authorities assert that the soil of the Magdalen islands is well suited for agricultural purposes, and richer than that of Prince Edward Island, which is considered the Garden of the Gulf.

Inhabitants.—The population is about 7,000, principally of French descent. The exceptions are: Entry island, which is Scotch, and Coffin island, which is English. The people are of good moral character, cheerful, and industrious. The men are capable of enduring great fatigue, and unsurpassed as able seamen. They are expert as fishermen, which, with farming, is their principal occupation.

Roads.—The islands are furnished with good roads, well maintained and good accommodation for driving can be secured at reasonable rates, at almost any point.

Gypsum Deposits.—It would be very much a repetition of what has already been said to deal at length with the geology of the deposits on these islands. They occur practically as those of Nova Scotia and New Brunswick, in the lower Carboniferous measures, and associated with the deposits of carbonate of lime. It might be said, that here they are in a closer position to the irruptive rocks—dolerite and diabase—which make up the many conical-shaped hills, and are the nucleus of the whole geological structure of the Magdalen islands; and many times they form the lower members of the lower Carboniferous group.

The most important deposits occur on Grindstone, Alright, Amherst, and Entry islands.

On Entry island the gypsiferous area, consisting of 208 acres, occurs on the south coast, near the lighthouse. It is well exposed on the sea shore, in the immediate vicinity of the irruptive rocks, overlaid by heavy beds of marl, containing boulders of dark limestone and gypsum, with veins of the fibrous variety cutting through it in many directions.

Some of the fibrous gypsum is very pure and white. Samples are shown in Plate IV. The gypsum is a soft granular variety, varying in colour from white to dark grey.

At Amherst it occurs in considerable dimensions in the same position with the older rocks, on the coast at Pleasant bay east of Demoiselle hill, and has a total area of 720 acres. It extends inland almost to the southern coast, a di- tance of nearly 1½ mi[illegible] and skirting the hill appears again on the coast we of Demoiselle. The d[illegible] are well exposed on the coast, and are traced inland by deep depress[illegible] or sinkholes. Some of these depressions are an ac or more in area, and from [illegible] to 50 feet deep. In the larger of these the gypsu may be observed. Tl[illegible] a white compact variety, with parts of it showi red streaks.

An area of [illegible] appearance, consisting of about 400 acres, occurs the northwest of [illegible] xtending from Southwest cape to West poi The gypsum here o[illegible] he coast, and has associated with it marls [illegible] ing fibrous gypsum.

Grindstone isla[illegible] rgest [illegible] 20 square miles) and most prom nent exposures of al[illegible] on the sea coast a short distan north of Cape Meu[illegible] marl and limestone and extending nort wardly 1½ miles, wh[illegible] tcrops on the Arsneau property with co siderable prominence. It has [illegible] dirty grey colour, and a large portion of has a granular textu[illegible] From the shore it can be traced westwardly, followi the contour of the hills, by outcrops and depressions, to Etang du Nord, whe it outcrops on lot 184, in a prominent ridge, and also on the adjoining lot, in depression which forms a pond of water, and where cliffs may be seen on o side from 40 to 60 feet high. Again, about midway between the coast and Eta du Nord, on vacant lands, more outcrops are observed. The rock presents ma varieties both of colour and texture, as will be noted below in the table analyses.

Again, skirting the irruptive cliffs near Cape Alright on Alright islan another very similar gypsiferous area is seen. The high cliffs at this point a only the remnants of one or more irruptive hills, that form the base of t gypsum deposits, and, therefore, the exposures of gypsum on the sea coast a not extensive. Inland, however, the same conditions are observed, and outcro are seen in several places on the higher grounds, and where the depressio have left the gypsum exposed. This area extends westwardly across the island Little bay, but here the land is low and the gypsum concealed.

Many years ago a few small cargoes of gypsum were taken from the islands to the Quebec market, but owing to the indiscretion of the operato in making a selection of the rock, the results were not satisfactory. Since th time no attempts have been made to develop or even test these deposits, whi showed much evidence of the existence of a good variety of gypsum, and evidence of the occurrence of anhydrite.

The deposits are not as prominent nor as extensive as many of those Nova Scotia and New Brunswick, yet with their vantage-point for the Can dian market they should be considered among those having considerable co mercial value.

Cape Meule, Grindstone island. Showing a characteristic rounded topped hill of the Magdalen islands.

289—p. 100.

The following are the results of analyses of samples taken from the different deposits:—

—	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
	%	%	%	%	%	%	%	%	%	%	%
Lime	32·61	30·50	32·73	32·70	32·63	32·30	32·93	31·98	32·29	32·49	32·67
Magnesia	tr.	0·25	tr.	tr.	....	0·46	tr.	0·59	0·40	....	tr.
Ferric oxide and alumina	0·10	1·36	0·20	0·20	0·16	0·82	0·24	0·46	0·41	0·18	0·12
Sulphuric anhydride	46·37	43·94	45·38	45.51	45·72	44·69	44·93	46·16	44·86	46·41	46·03
Carbonic anhydride	....	0·27	0·79	1·20	0·57	1·33	0·86	....	·23	tr.	....
Water, loss on ignition	20·60	19·75	20·50	20·30	20·25	20·35	20·00	20·10	20·00	20·35	20·82
Insoluble mineral matter	0·20	3·62	0·10	0·10	0·36	0·30	0·60	0·80	1·12	0·12	0·32
	99·88	99·69	99·70	100·01	99·69	100·25	99·56	100·09	100·31	99·55	99·96

No. I. From lot No. 100, Alright island: a very pure white compact roc
" II. Fibrous gypsum associated with the gypsum, Alright island.
" III. From lot No. 184, Etang du Nord, has rather a salty structur with a greyish white colour.
" IV. White compact gypsum taken from an exposure in the wall of sink hole or depression at Etang du Nord, near lot No. 184.
" V. Sample of pink rock associated with the marls in cliffs near Cap Meule, Grindstone island.
" VI. A dirty greyish granular rock from Arsneau lot, Grindstone islan
" VII. An average sample taken from vacant lands on Grindstone islan greyish white, with compact texture.
" VIII. A dark bluish rock from Ryan cove, Grindstone island.
" IX. Dark greyish with selenitic crystals, occurring on the shore ne Cape Meule.
" X. Fibrous gypsum from Entry island, shown in Fig 2.
" XI. White compact gypsum, with some streaks of red, occurring on th shores near Demoiselle hill, Amherst island.

CHAPTER VI.

Manufacture of Plaster.

By referring to the formula for plaster of Paris, on page 36, it is seen that about two-thirds of the original water of crystallization or combined water has been driven off, in course of the process. Dehydration to this extent can, as above noted,[1] be accomplished at any temperature between 212° F. and 400° F.; it is found, however, for economy of fuel and time, that it is best to carry on the process at the highest allowable temperature.

Two operations are necessary in the manufacturing of plaster of Paris; the mineral must be finely ground, and properly calcined. The grinding either precedes or follows the calcining; the order of the two operations depends on the method used in calcining. If the method of calcining is by kettle, the grinding is usually done first; if the calcining is carried on in kilns or rotating cylinders, the raw material is fed to them as it comes from the crusher, and the fine grinding follows.

In the typical American mills using the kettle calcining process, the general operations are as follows:—

The lump gypsum, as taken from the quarry, is dumped into a bin, which automatically discharges it on to a rock slide. It is dumped directly on to the rock slide, down which it runs to the nipper, a reciprocating jaw crusher, passing through which it falls into the cracker, which is a heavy machine of the coffee mill or toothed spindle type. This reduces the crushed rock to the size of an average grain of corn. From the cracker the material goes to a rotary dryer, which eliminates about 10 per cent of the moisture. Next, the rock is screened over a screen of about 24 mesh, the fines going direct to the bins over the kettles, and the coarser material drops into an elevator, which raises it to bins over the millstones (For particulars see diagram showing flow of material from screen to kettle, Fig. 12, and Fig. 14.). From here it is fed automatically into the millstones, where it is reduced to flour, and conveyed by an elevator to the kettle bins, from which it is run into the kettles as required. A batch for a 10 ft. kettle is about 10 tons of gypsum flour, and when about two-thirds of the water of crystallization is driven off (requiring about 2½ hours), it becomes plaster of Paris; and from a door in the side of the kettle, near the bottom, it is run off into what is known as the hot bin, built in the ground behind the kettles. The material from here slides down the inclined bottom of the hot bin, through gates into a spiral conveyor, by which it is taken to an elevator and discharged into classifiers, which separate the coarser particles. The product, coarse and fine, is taken by two conveyors into the warehouse; the fine being

[1] See formula page 36.

deposited either in the mixer bin or the plaster of Paris bin, while the coarse particles pass to a bin over regrinding millstones, and after passing through them, is again elevated and rejoins the fine material. By means of gates in the floor beneath the plaster of Paris bin, the material drops through spouts into bags. for shipping neat. The plaster of Paris in the mixer bin drops through to the mixers, being therein mixed with fibre and retarder, and is then bagged and shipped as hard wall plaster.

DESCRIPTION OF MACHINERY.

The nipper or jaw crusher (Plate XXIX) is used for coarse reduction.

It is designed to stand heavy strains and rough usage. When used for gypsum crushing it is usually equipped with corrugated jaws to prevent clogging. The machine shown in the illustration has a jaw opening of 15″ × 22″ with a capacity of material to pass a 2″ ring of 12 to 25 tons per hour; approximate weight 10,000 pounds; 36″ × 10½″ belt pulley; and with a speed of 200 revolutions requires 15 horse-power. It is listed at $550. A similar crusher having a capacity from 25 to 40 tons, and jaw opening of 22″ × 28″, is quoted at $850.

The nipper is usually followed by the cracker (Plate XXX), and will reduce the product to the fineness of corn.

The machine is of the rotary type, provided with break pin safety pulleys, and is listed at $650. The dryer is a cylinder 4 feet in diameter, by 27 feet long, weight 21,000 pounds. It should be equipped with an automatic feeder and exhaust fan. It is built in brick-work, similar to a horizontal boiler, and is listed at $2,500. Any kind of fuel oil, gas, coke, coal, or wood may be used, but the products of the fire should not come in contact with the material being dried, as it is liable to discolour it.

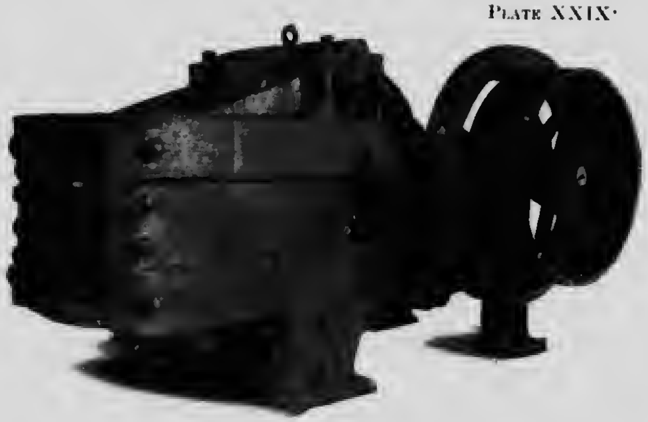
The classifier is used to separate that portion of the material already crushed sufficiently fine for calcining purposes from the material requiring grinding, and gives greater efficiency to the millstones.

The classifier shown in Plate XXXI is a new machine, recently put on the market by the J. B. Ehrsam & Sons Mfg. Co., of Enterprise, Kansas, U.S.A., and it is reported as giving excellent results. It will handle from 10 to 15 tons of ground gypsum per hour, and take out 100 mesh fines. It occupies a floor space of 8 × 6 feet, and is 6 feet high; weighs 4,500 pounds, and should be run at a speed of 800 to 1,200 revolutions per minute, according to the capacity required. The machine is provided with a cut off, so the amount of fines may be regulated from 80 to 100 mesh, as may be desired; and the product is not affected by the fluctuation of 50 or 100 revolutions per minute, or irregular feeding, which is a feature to be desired in mill practice.

For final reduction there are various mills designed, as the Stedman disintegrator, the Sturtevant rock emery mill, and the French burr millstones. The latter are generally used and give the most satisfactory results.

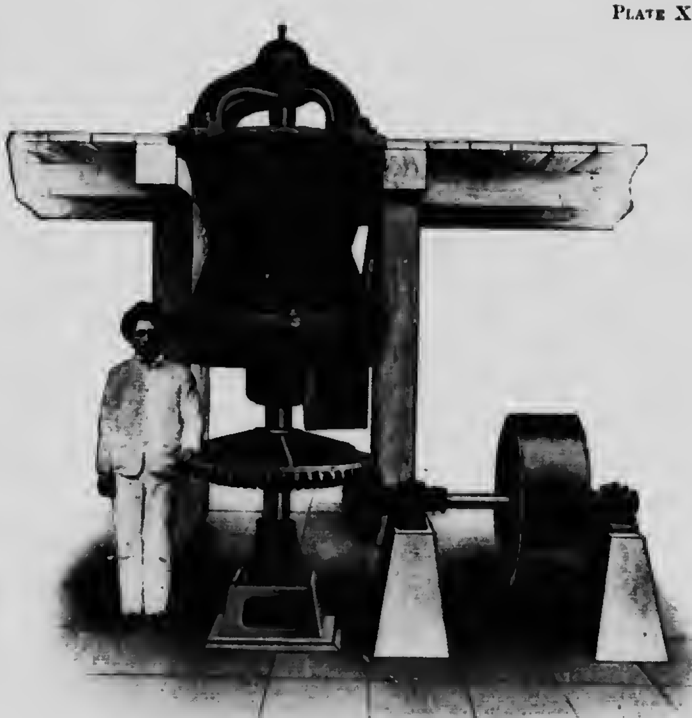
The Stedman disintegrator is composed essentially of four concentrically placed steel bar cages. Of these cages the first and third revolve in one direction

PLATE XXIX.

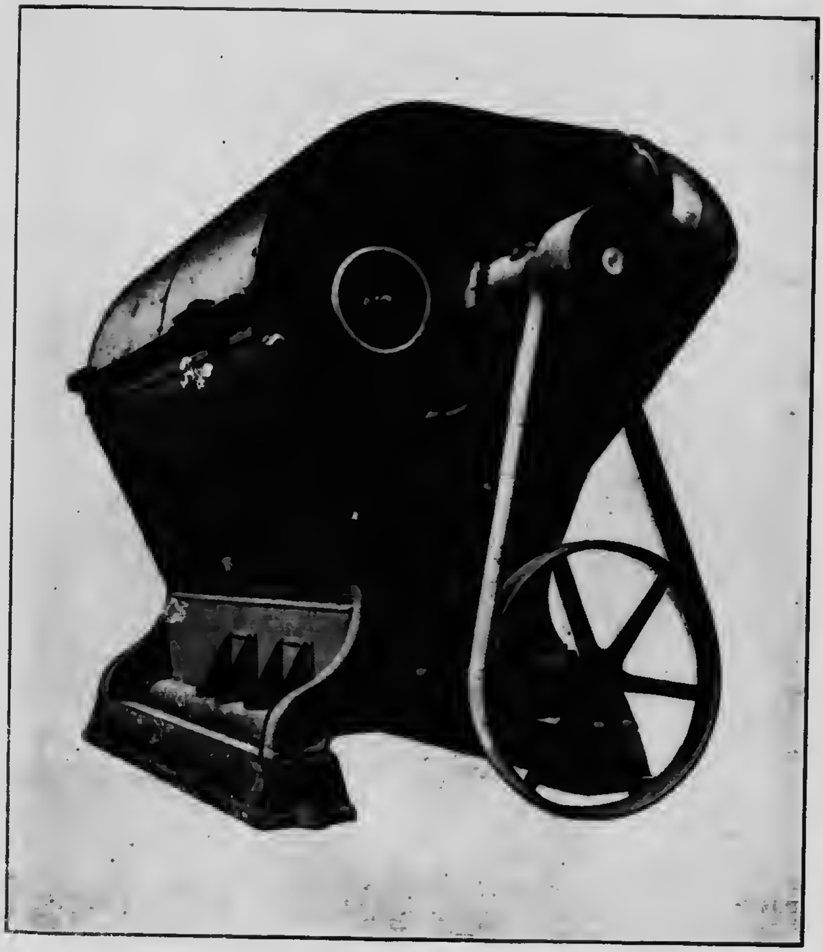


Nipper or Jaw Crusher used for coarse reduction.

PLATE XXX.



Cracker for fine reduction.



Classifier.

while the second and fourth revolve the opposite way. The material is fed into a hopper, which discharges it into the centre of the cages. The gypsum lumps are struck by the bars of the inner cage, and thrown outward at high velocity; the bars of the second cage, revolving in an opposite direction, strike them a blow of double force, and the operation is repeated by the third and fourth cage in succession, completing the reduction.

In the Sturtevant rock emery mill, the ordinary millstones are replaced by a manufactured stone. It is constructed with a circular iron cup or shell, the centre is made of a disc of burrstone, while the portion near the rim is set with slabs of rock-emery, cemented by metal poured in while molten. Radial strips of burrstone are set so as to continue the furrows from the central burrstone to the rim of the wheel.

The French burrstones are too well known to require description.

The burrstone mills are made to operate vertically or horizontally, the former in most cases being preferable.

Plate XXXII represents the Enterprise vertical burr mill, which is especially designed for gypsum grinding. The mill is simple in construction, provided with a spreading device to throw the stones apart when not grinding, and bring them together again when grinding is resumed, without changing the adjustment screw. The spindle and bearings are made especially strong, and the latter dust-proof. The spindle is also provided with a safety device, which allows the stones to spread apart, preventing accidents when harder foreign substances get mixed with the material being ground. The stones are made interchangeable, and can easily be removed for dressing; when two or more mills are installed, it is advisable to have an extra pair of stones, which will enable the operator to keep the mill in operation while the stones are being redressed.

These mills are provided with a mechanical feeder which guarantees uniform feeding of the required capacity. The 36″ mill requires a floor space of 9′-3″ × 4′-2″; its height is 5′-9″; approximate weight, 6,800 pounds; listed at $650, extra burrstones 36″ diameter are listed at $134 per pair.

Calcining kettles are constructed in the form of a hollow cylinder, made of boiler steel, from ¼″ to ⅜″ thick. Their depth is about equal to their diameter, ranging from 6 to 10 feet. This cylinder is set on an iron ring, and on the ring inside the cylinder rests the bottom. The bottom is cast, and should be made from the very best scrap iron, and also of such a mixture of iron as to make the shrinkage as low as possible. It is convexed upward, and has a thickness of about ⅝″ at the edges, and 4″ at the crown. Sectional kettle bottoms are sometimes used, made of six radial sections and one round centre piece, and although they are not always satisfactory on account of unequal shrinkage, yet as the life of a kettle bottom terminates with cracking, it has merits, as any cracked section may be replaced without disturbing the kettle or the brick-work.

The top of the kettle is covered with a sheet iron cap, having a movable door through which the raw material is introduced, and a stack hole for the escaping vapours. The old style kettles were built without flues passing through them, but in all modern kettles they have two or four flues. Plate XXXIII shows the general construction of Ehrsman's four flue kettle, in brick setting.

In this the furnace gases come in contact with the kettle bottom, enter the tuyeres placed around the entire inside circumference of the wall supporting tho kettle, after which they travel in an annular chamber around the circumference of the shell to tho two lower tubes, passing through them to an upper annular space, again around the circumference to the two upper flues, thence to the chimney.

The kettles are usually arranged in lino, and operated in pairs, having one feeding chute and one hot pit for each pair. It is necessary that the material in the kettle should be constantly agitated, and for this purpose a line of shafting is placed over the kettles, which has attached, for each kettle, a 4 ft. vertical pinion wheel, which drives a horizontal cog crown wheel, attached to a 4″ vertical shaft running to the bottom of the kettle, and supported in the centre by bearings attached to the flues. Above the flues, on the vertical shaft, is attached a paddle-shaped cross arm, and at the bottom a curved cross arm having either movable teeth with paddles, or chains which are so adjusted as to throw the material from the outside to the centre; revolving at about 15 revolutions per minute and requiring from ten to twenty horse-power. If, from any cause, the agitation should stop, the material settles down on the bottom, and, owing to the intense heat, the bottom is very liable to be melted.

The kettle flues gradually increase in diameter from 7″ to 16″, and when four are placed in a 10 ft. kettle, on a horizontal line, they are 36″ apart, but when placed in pairs two above the other, they are from 10″ to 15″ apart.

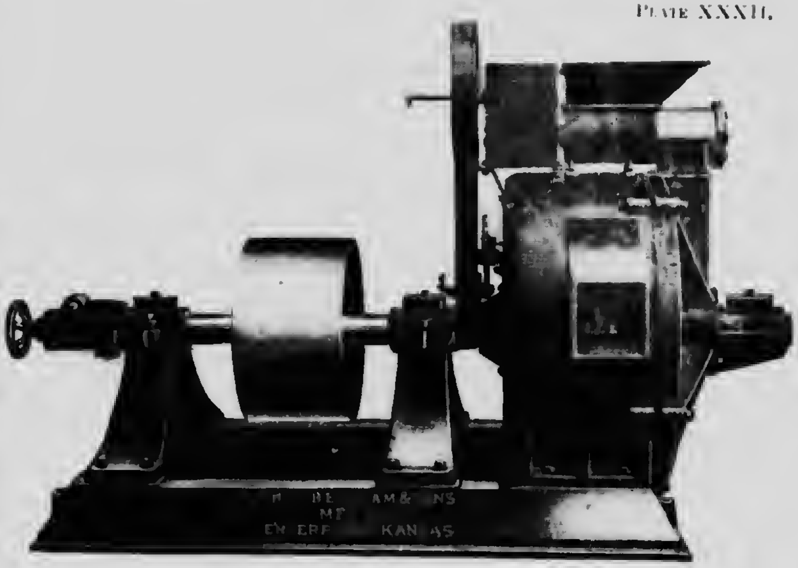
In the matter of fuel economy, experiments between two kettles, one with four flues placed on a horizontal line, and one with four flues placed in pairs, two above the other, were tried by Mr. Lowe of Grand Rapids. The results are given by Grimsley[1]:—

'The kettles were properly set and with good draft. The gypsum was ground so that 85 per cent would pass through a 40 mesh sieve. The experiment was watched on the second batch after the kettle had been fully heated. The material was discharged after the second setting, and was fully calcined, and the weight of plaster was eight and one-fourths tons, with a water percentage of five and one-half.

Type of Four-flue Kettle.	Condition of Rock.	Pounds of Bitum. Coal.	Time in Hours.	H. P. Required.
Direct, flues 0000	Green	1,030	3 7-12	12
Return, flues $\genfrac{}{}{0pt}{}{00}{00}$	"	880	3 8-12	13
Direct, flues 0000	Dry	850	2 10-12	10½
Return, flues $\genfrac{}{}{0pt}{}{00}{00}$	"	730	2 11 12	11½

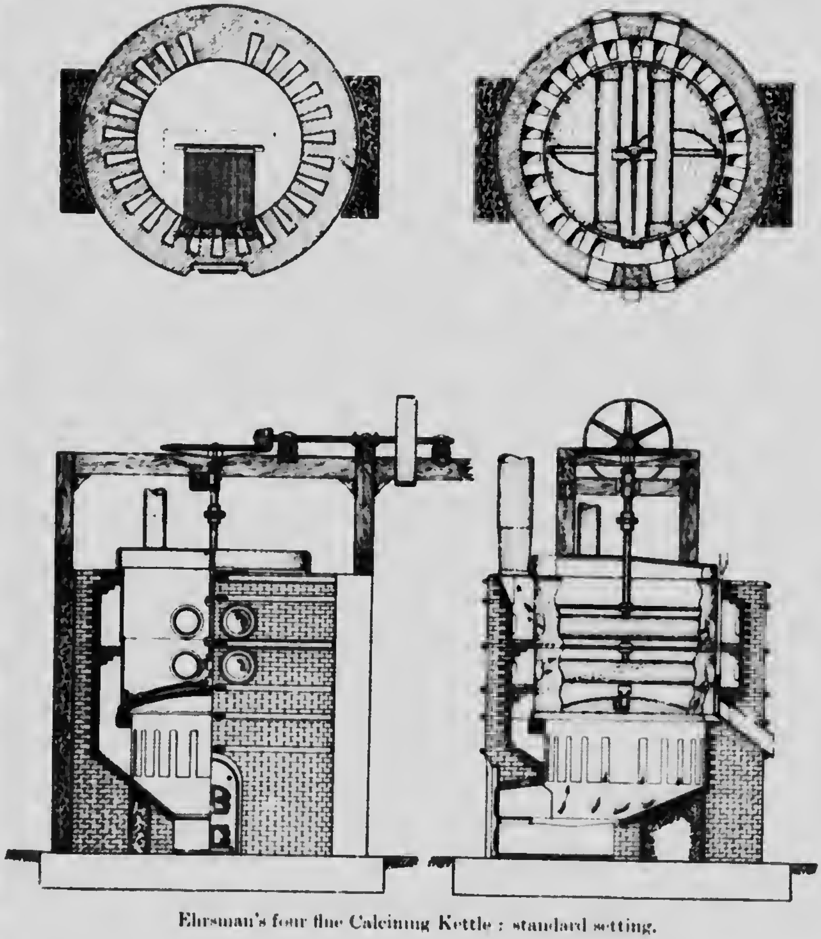
[1] The Gypsum of Michigan, Vol. IX, Part II, p. 123.

PLATE XXXII.



Vertical Burr Mill.

PLATE XXXIII.



Ehrsman's four flue Calcining Kettle : standard setting.

'The material in the second experiment was discharged at the end of the first settling, and the total weight of plaster was eight and one-half tons, with a water percentage of eight. In the direct arrangement the heat passes through flues and out. In the return, the heat passes through two flues, then back through other two and out.

Type of Four-flue Kettle.	Condition of Rock.	Pounds of Bitum. Coal.	Time in Hours.	H. P. Required.
Direct, flues 0000	Green	765	$2\frac{9}{17}$	12
Return, flues $\frac{00}{00}$	"	660	2[illegible]	13
Direct, flues 0000	Dry	600	$2\frac{1}{12}$	$10\frac{1}{2}$
Return, flues $\frac{00}{00}$	"	520	$2\frac{7}{12}$	$11\frac{1}{2}$

In starting a kettle, the heat is gradually increased while the crude material is being slowly fed. The material thus gradually added is constantly agitated; when the kettle is full and the temperature rises to about 225° or 230° F., the contents boil violently as the water is driven off and out the vapour stack. When the temperature reaches about 270° F., the gypsum settles down, leaving a vacant space of about 16", and the steam almost ceases. This is known as the first settling. Between 280° and 290° F., the mass rises again, often throwing part of the material over the top of the kettle, and when a temperature of 350° to 370° F., is reached, the process is completed and the material is readily withdrawn through the gate near the bottom, which is controlled by a lever from the top.

Table Showing Details of the Ehrsam Calcining Kettles.

Diameter of kettle ... Ft.	6	8	8	10
Height of kettle ... Ft.	6	5	8	[illegible]
Number of flues	2	2	4	4
Diameter of flues ... In.	12	14	14	16
Thickness of shell in kettle ... In.	[illegible]	[illegible]	[illegible]	[illegible]
Thickness of tubes in kettle ... In.	[illegible]	[illegible]	[illegible]	[illegible]
Diameter of smoke stack ... In.	14	20	20	24
Length of smoke stack ... Ft.	40	48	48	48
Grate surface ... Ft.	2 × 3	3 × 4	3 × 4	4 × 5
Diameter of upright shaft ... In.	3[illegible]	3[illegible]	3[illegible]	4[illegible]
Length of upright shaft, lower section	7'-6"	7'-6"	9'-10"	9'-10"
Length of upright shaft, upper section	3'-6"	3'-6"	3'-6"	4'-0"
Number of gear wheel	S146	S147	S147	S170
Number of pinion	S146	S147	S147	S170
Number of kettle bands	3	4	4	6
Weight of kettle and fixtures ... Lbs.	6,000	12,000	13,000	20,000
Number of common brick above floor	10,000	16,000	17,000	23,000
Number of firebrick	2,000	4,000	4,800	7,000
Capacity per charge ... Tons.	2 to 3	5 to 6	6 to 7	12 to 14
Power required on ground gypsum under ordinary conditions ... H.P.	8	15	15	25
Price	$450	$800	$900	$1,200

Kettle fixtures comprise: front with doors and liners, front, grate rests, grate bars and back grate rest, one kettle ring made in sections with bolts and couplers, one kettle bottom, two flue doors for each flue in kettle, stack plate and stack with guy wires four times the length of stack, kettle bands, one kettle cover made of sheet steel of the extension pattern, one vapour pipe made of galvanized sheet steel, one agitator shaft and bottom agitator with rakes or chain, flue agitator, shell agitator, adjustable flue bearing, adjustable bridge bearing, cast iron gear wheel and steel pinion; also one pair of double gates and rods with shield and discharge spout.

The mixer is a machine having essentially two compartments, a mixing chamber, and a sacking chamber. The mixer has one mixing shaft, with two sets of paddles so arranged that one set throws the material from the outside of the mixing chamber towards the centre; at the same time causing the material to travel towards one end of the mixing chamber; while the other set of paddles causes this operation to be reversed. All working parts are made of iron or steel. The main shaft and stuffing boxes are made extra heavy, the main bearing independent of the stuffing boxes. The mixer is provided with wooden receiving hopper, lined with sheet steel. By operating a lever the operator discharges the material from the hopper into the mixing chamber. After the material has been in the mixing chamber a sufficient length of time (from 3 to 8 minutes) the operator, by turning a pilot wheel, opens the valves to the sacking chamber, which allows the material to discharge into the sacking chamber. This is made of wood, lined with sheet steel, and provided with an agitator to keep the material from clogging; it also allows the mixed product to be discharged directly into sacks for shipping.

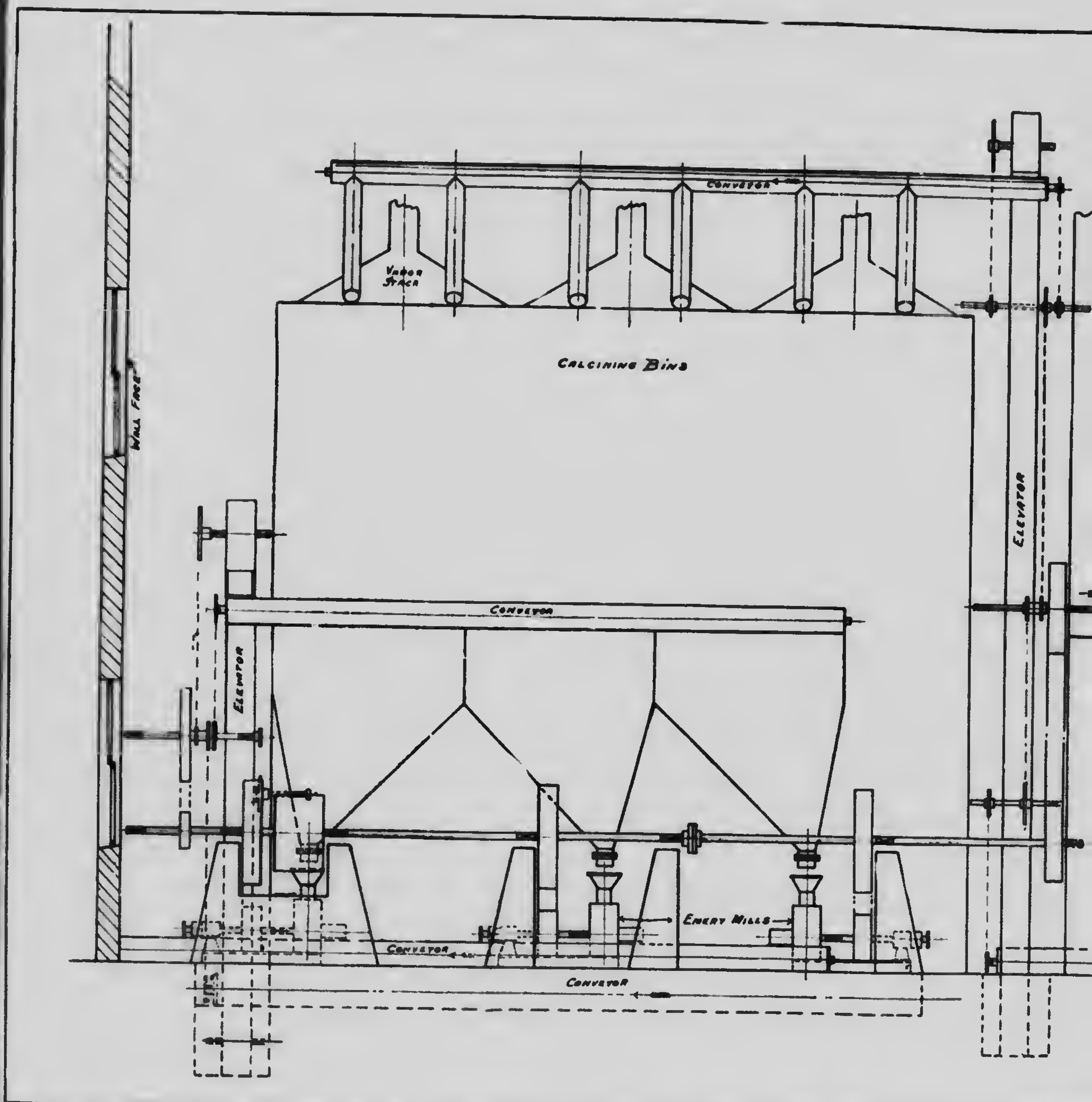
In Plate XXXIV the Enterprise noiseless mixer is shown. It is made in two sizes, No. 1 having a capacity from 1,000 to 15,000 pounds to a charge, and from 45 to 65 tons per day of 10 hours; weight 3,800 pounds; listed price $325. No. 2 has a capacity from 1,800 to 2,400 pounds to a charge, and from 80 to 100 tons per day of 10 hours; weight 4,400 pounds; listed price $400.

Somewhat similar mixers are furnished by the Des Moines Manufacturing and Supply Company. They are known as the Broughton mixers, with style, capacity, etc., shown in the following table:—

—	Style A—1	Style A	Style B—1	Style B—2	Style B—3
Capacity of hopper, lbs.	1800—2000	1000—1400	600	500	250
Bag-holders, number.	6	5	...	...	
Product per day of 10 hours, tons	60—90	35—50	35	15	7½
Size of pulley, inches	30 × 12	24 × 8	24 × 8	20 × 6	16 × 4
Revolutions per minute	150	160	175	160	160
Horse-power required	18-22	8-12	8-12	5-7	3-4
Shipping weight, Lbs.	7,300	4,750	3,800	2,300	
List price, $	675	450	400	300	250

PLATE XXXIV.

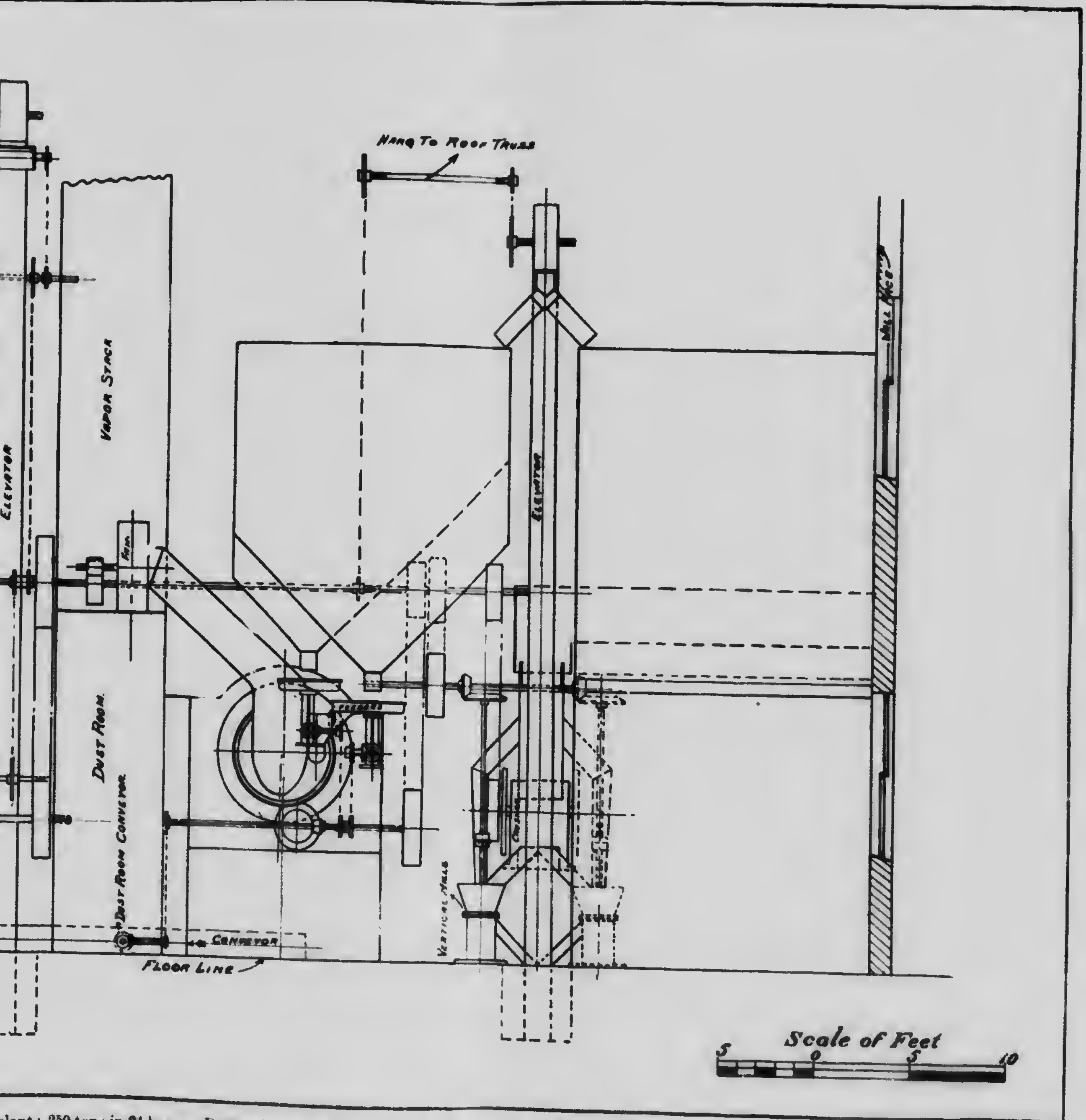
Enterprise Noiseless Mixer.



289—p. 108.

Side elevation of Cummer continuous calcining plant; 250 t

FIG. 4.



plant; 250 tons in 24 hours. Designed by the F. D. Cummer & Son Co., Cleveland, Ohio, U.S.A.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)

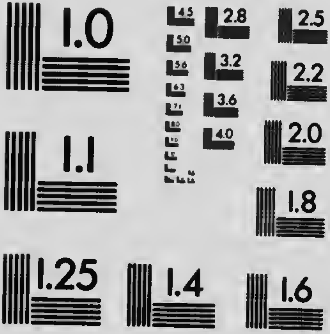
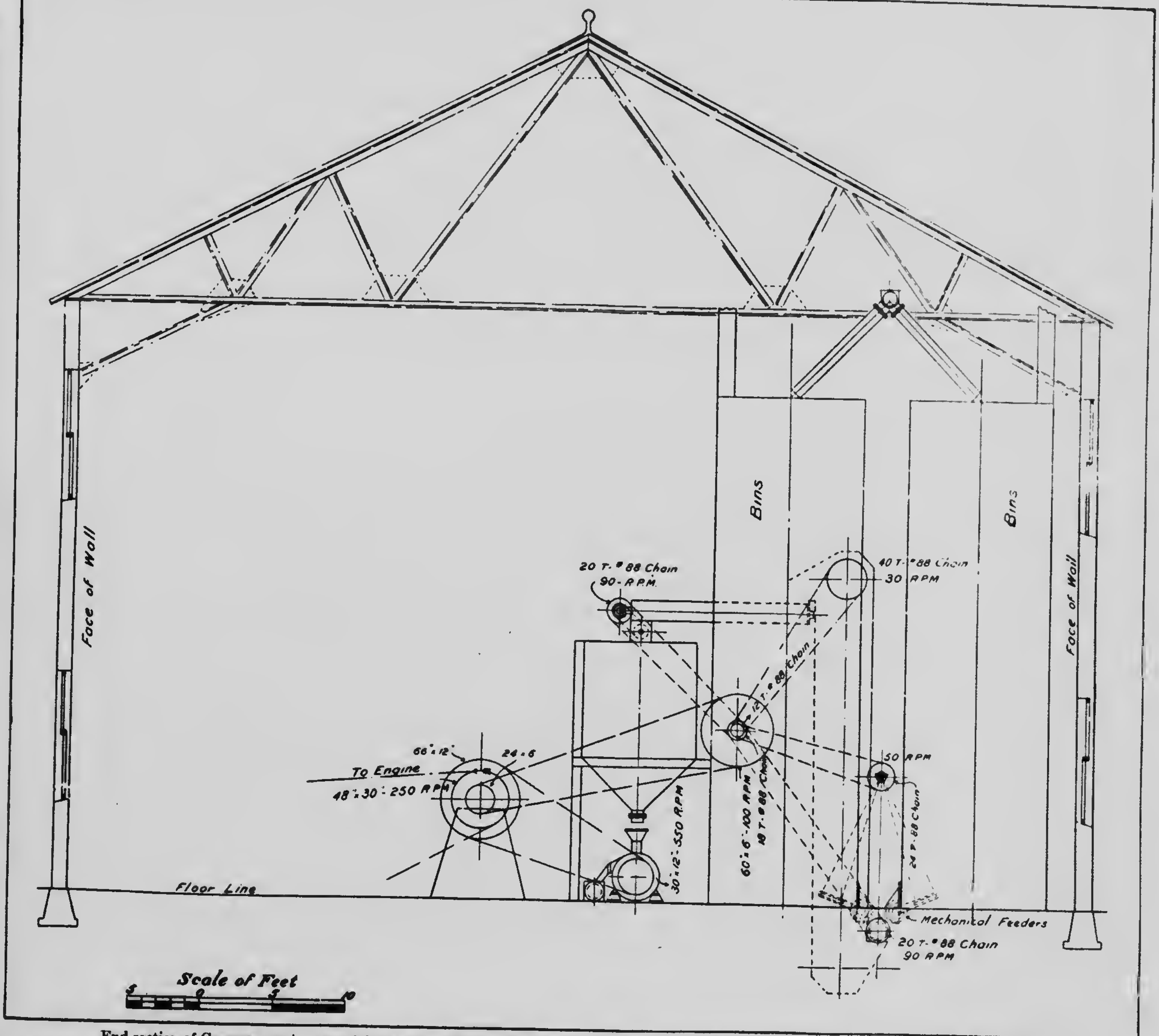
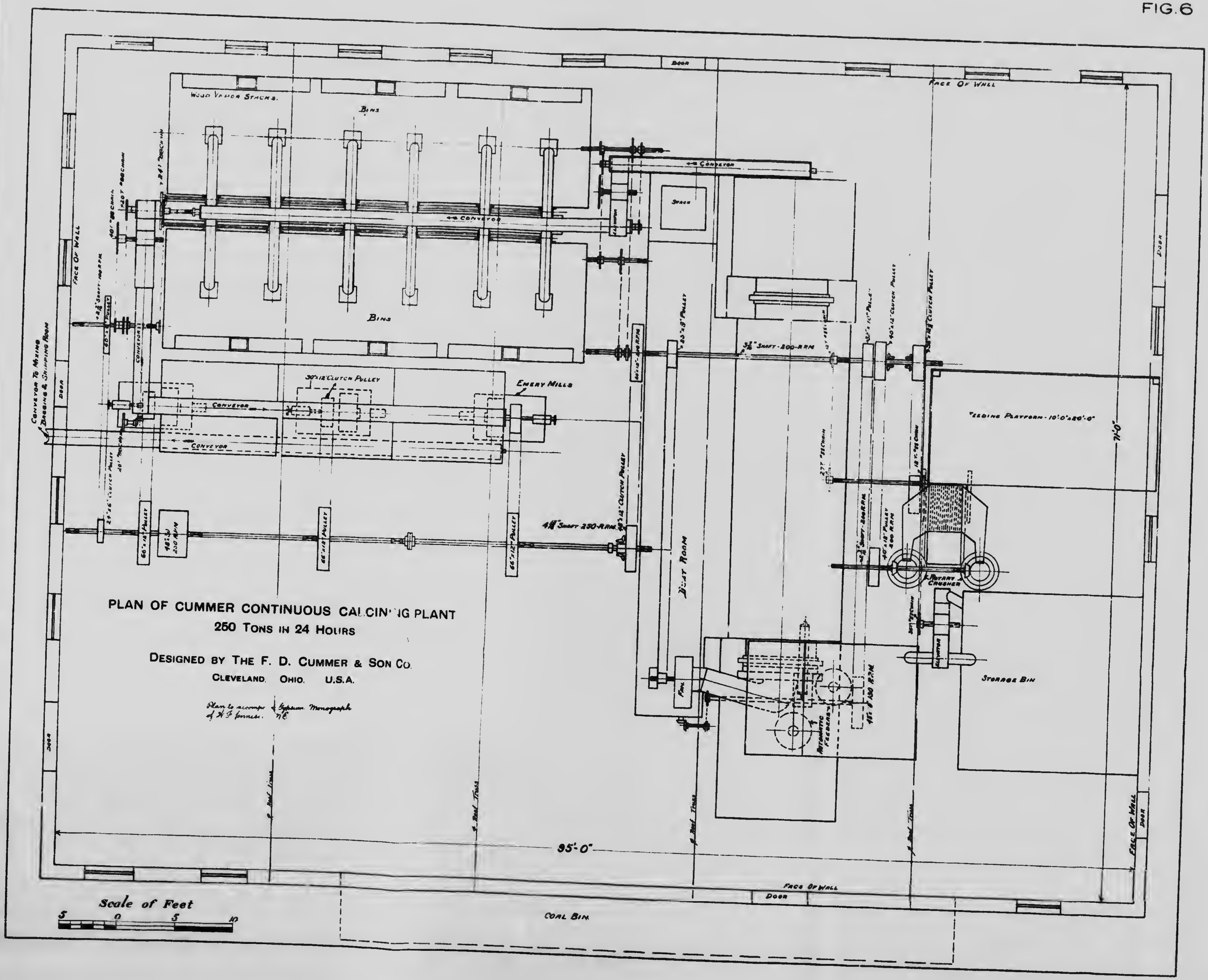


Fig. 5.



End section of Cummer continuous calcining plant; 250 tons in 24 hours. Designed by the F. D. Cummer & Son Co., Cleveland, Ohio, U.S.A.

FIG. 6



PLAN OF CUMMER CONTINUOUS CALCINING PLANT
250 TONS IN 24 HOURS

DESIGNED BY THE F. D. CUMMER & SON CO.
CLEVELAND. OHIO. U.S.A.

Scale of Feet
5 0 5 10

OBJECTIONS TO THE PRESENT SYSTEM OF CALCINING GYPSUM.

To the present system of kettle calcining there are several objections. It is not a continuous process, and it requires a great amount of heat to perform the work and is, therefore, expensive; when the kettles are at their highest temperature they are discharged and recharged with cold material, and although the recharging is done gradually, there is large loss of heat, besides constantly causing contraction and expansion, which is a serious strain on construction. Another objection is the large horse-power required to keep the gypsum flour agitated, not only to prevent it from burning at the bottom, but also to prevent the kettle bottom from overheating. Many and various attempts have been made to overcome these objections by using rotating cylinders, but they too have their difficulties. The various qualities of our gypsums require different lengths of time to perform complete or partial calcination. The objection made to the cylinder process is the difficulty to determine that point. The expert calciner cannot see the plaster boiling, and all his tests—the rising vapours, the creaking machinery, etc.—have disappeared or become so modified that he can no longer recognize them.

There is no doubt, however, that in the near future these difficulties will be overcome, and we will have a continuous process that will give a uniform product with less expense, and the old time kettle will disappear.

THE CUMMER SYSTEM.

The Cummer continuous gypsum calcining process, shown by Figs. 4, 5, and 6, designed and furnished, with description, by F. D. Cummer and Son Company, of Cleveland, Ohio, is not without merit.

It consists of a rotary calciner and calcining bins. The rock coming direct from mine or from storage is crushed to ¾" ring, and delivered to a small storage bin situated over the feed spout of the rotary calciner. This bin is equipped with a mechanical feeder that regularly feeds the crushed rock into the calciner. In this machine most of the free water is eliminated, as well as some of the water of crystallization. The gypsum remains in the calciner about ten minutes, and during this time is in constant agitation and gives off moisture.

As it leaves the calciner it is steaming and heated uniformly to the desired temperature, which varies from 400° to 600° F. The exact temperature depends largely upon the density of the rock, and the kind of product desired.

From the rotary calciner the hot steaming rock is elevated to the calcining bins, where the calcining process is completed in about 36 hours. During this time the residual heat brought over by the rock from the calciner completes the calcining process already started, and the material is cooled, ready for the pulverizers. The now calcined material is mechanically discharged from the bins and conveyed to the pulverizers. While it is of the rotary dryer type commonly used for drying gypsum preparatory to calcining in kettles, it is entirely different in principle, and of much heavier design and construction.

The rotary calciner is equipped with a special mechanical stoker and furnace setting, with which combination perfect combustion is obtained with slack bituminous coal.

The pure, heated gases resulting from perfect combustion are drawn by a fan into a large commingling chamber, which extends the entire length of the cylinder. At the same time, sufficient air is admitted through regulators in the side walls of the commingling chamber, and mixed with the heated gases from the furnace, to give the temperatures best suited to the material.

The cylinder (which is set at an incline and revolves slowly on steel rollers) has a great many hooded openings, so arranged that the heated air and gases from the commingling chamber are drawn by a fan through the hoods into the cylinder, in direct contact with the gypsum rock, which enters the machine at the front end. The rock is constantly being cascaded in the cylinder by means of lifting blades.

In the discharge spout is a recording thermometer, which registers the temperature of the rock as it comes out and is elevated to the calcining bins. The dial of this recording thermometer is so located that the operator can watch it, and keep the rotary calciner adjusted so as to give a uniformly heated product.

The calcining bins are built of brick, or of wood lined with brick. Four bins are required for each plant, and the capacity of each bin is equal to the daily output of the plant. By the use of four bins a continuous process is obtained. One bin is being discharged of its cooled calcined material while the process of calcining is being completed on the material in the second and third bins, and the fourth bin is being filled with hot material from the calciner. These bins are so constructed that the material in process of calcination is thoroughly ventilated, while the outside air is excluded, which allows the residual heat carried by the material from the calciner to rapidly disseminate itself through the mass, and complete the calcining process. The temperature at which the material enters the bins determines the time of set.

Each bin is equipped with a simple device which mechanically discharges the material, regularly and at any speed desired.

Table giving Approximate Capacity, Fuel, Horse-power, and Labour, Cummer Continuous Calcining Process for Gypsum.

Number.	Capacity per 24 hours.	Horse-power.	Coal per day for calcining.	Labour per shift.
1..	50 tons	6	3,500 lbs.	1 man
2..	100 "	8	7,000 "	[illegible] "
3..	150 "	10	10,500 "	[illegible] "
4..	200 "	12	14,000 "	1 "
5..	250 "	15	17,500 "	1 "
6..	300 "	20	21,000 "	1 "
7..	400 "	28	28,000 "	2 men

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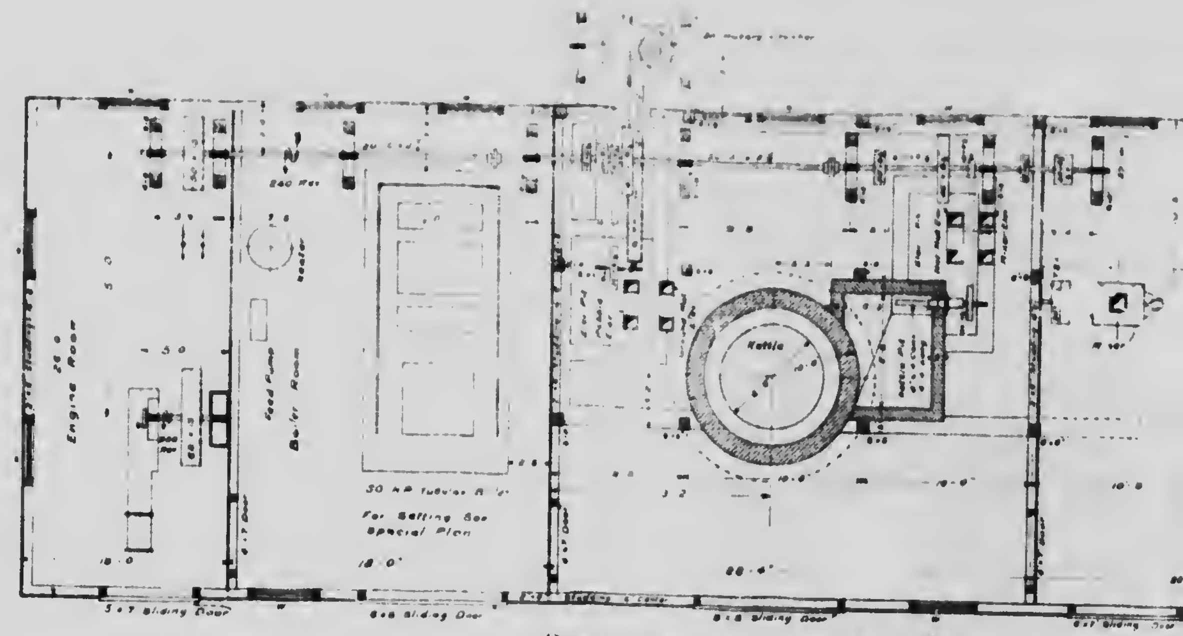
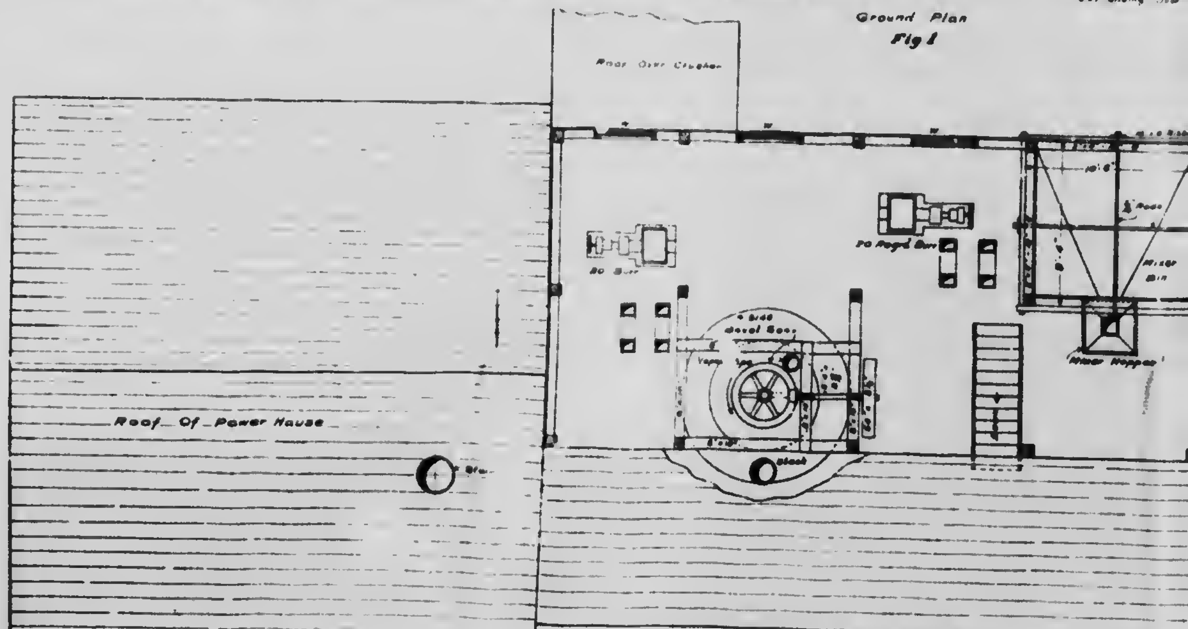
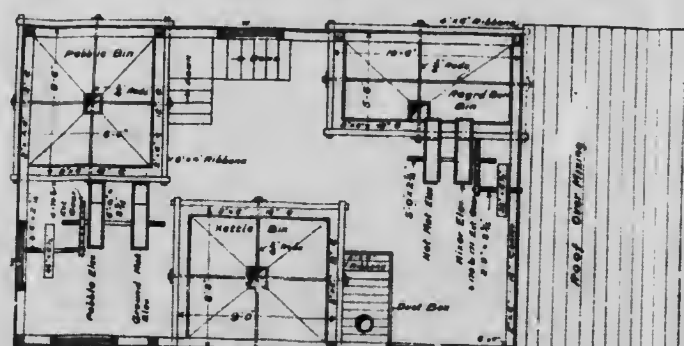


Ground Plan
Fig. 1



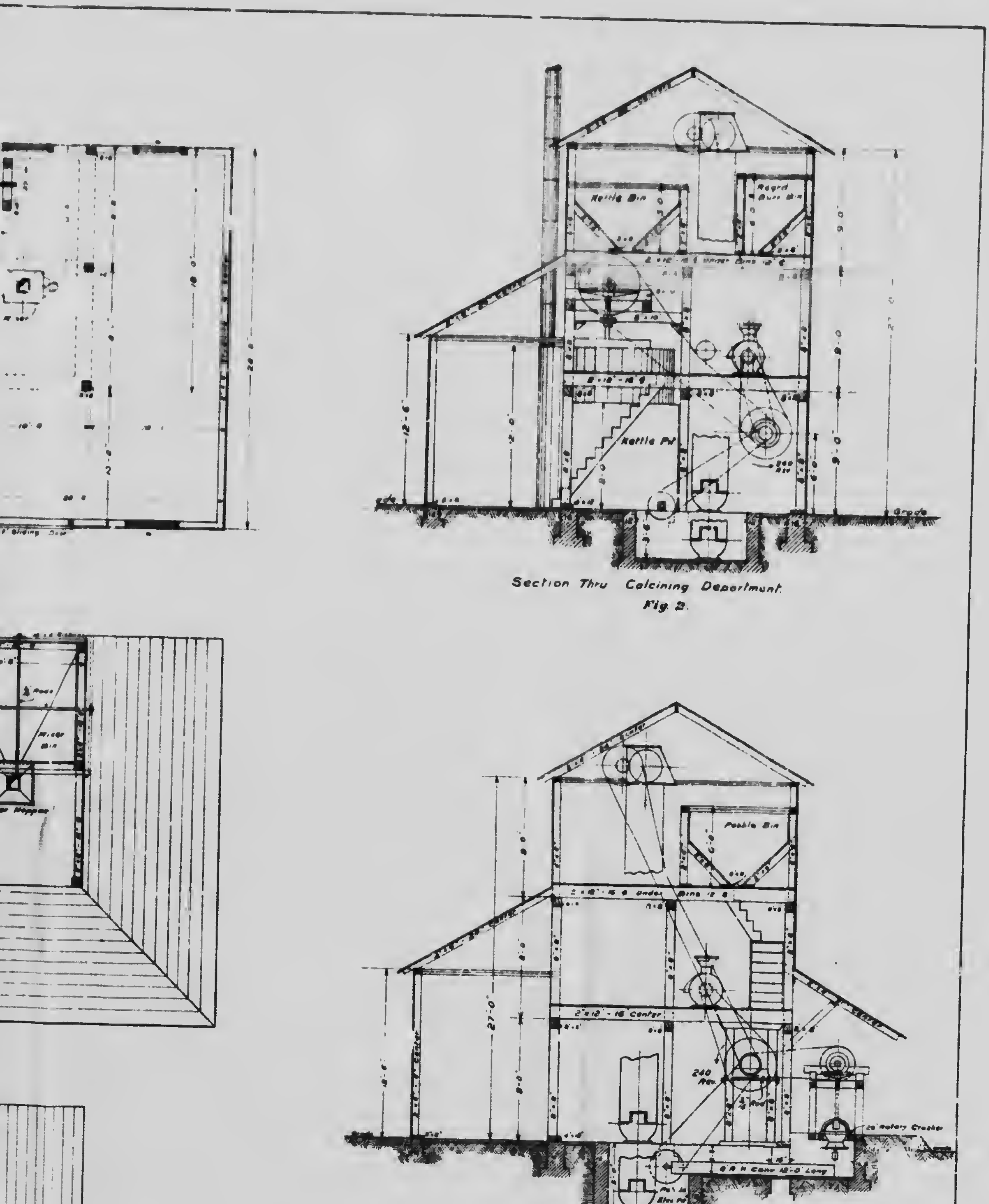
2nd Floor Plan
Fig. 3



3rd Floor Plan. Fig. 5.

1-6'-0" X 6'-0" KETTLE PLASTER

FIG. 7



Section Thru Calcining Department.
Fig. 2.

Section Thru Grinding Department
Fig. 4.

E PLASTER MILL

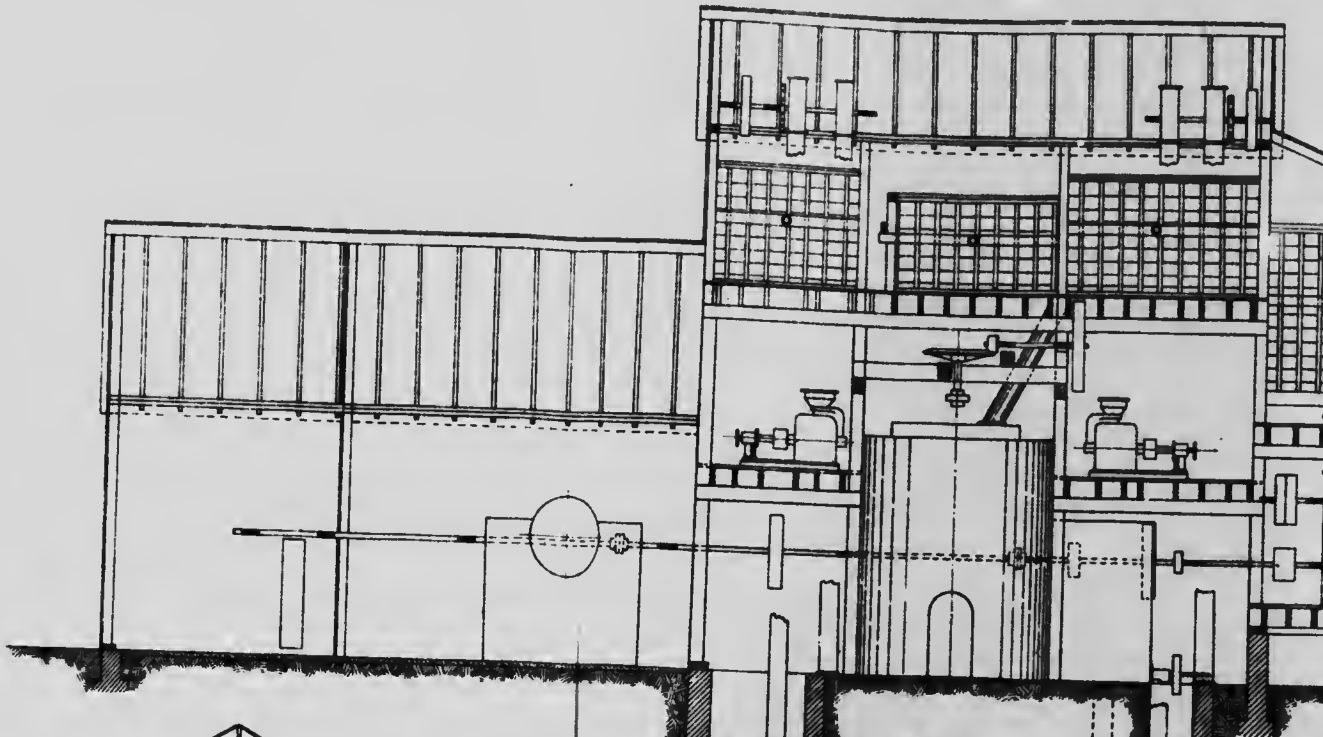
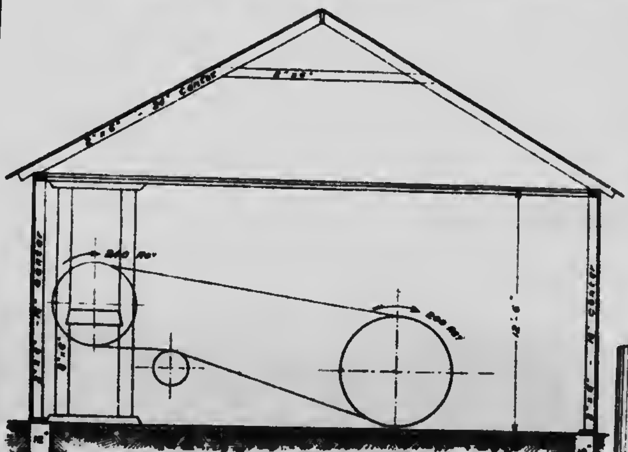
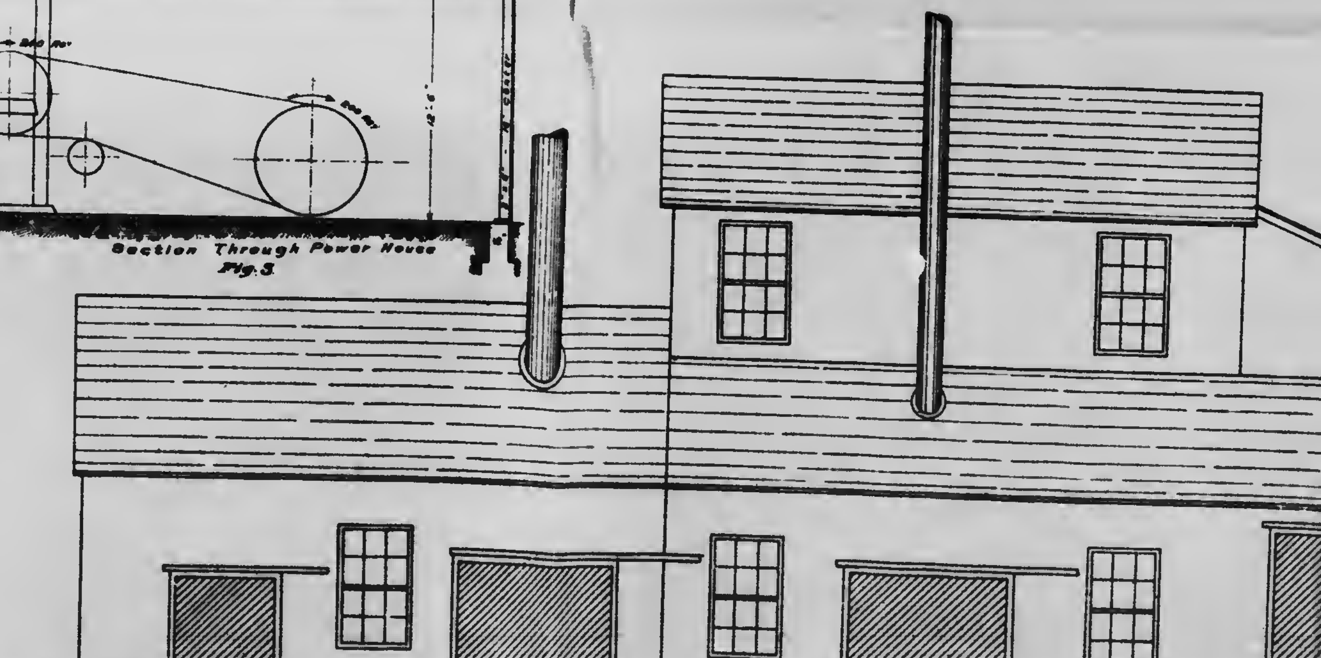


Fig. 1.

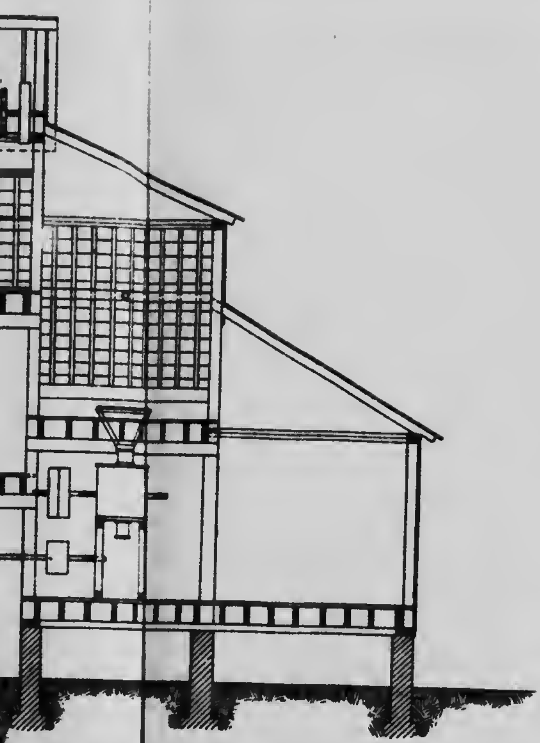


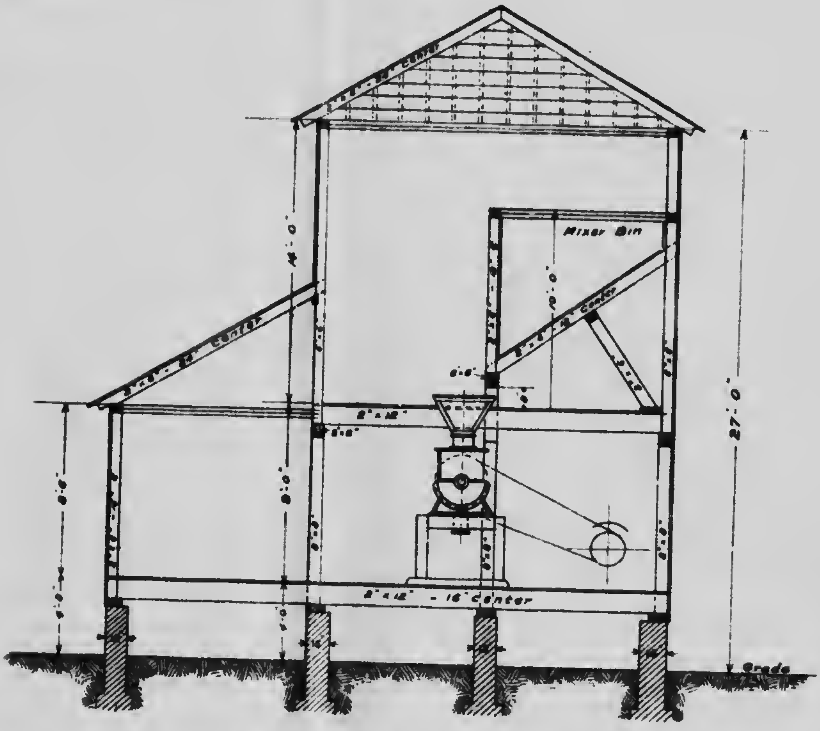
Section Through Power House
Fig. 3



1–6'-0" X 6'-0" KETTL

FIG. 8





Section Through Mixing Dept.
Fig. 2.

Fig. 4.

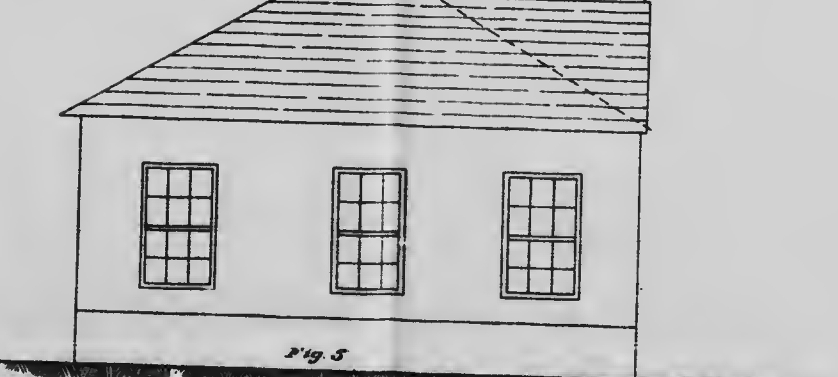
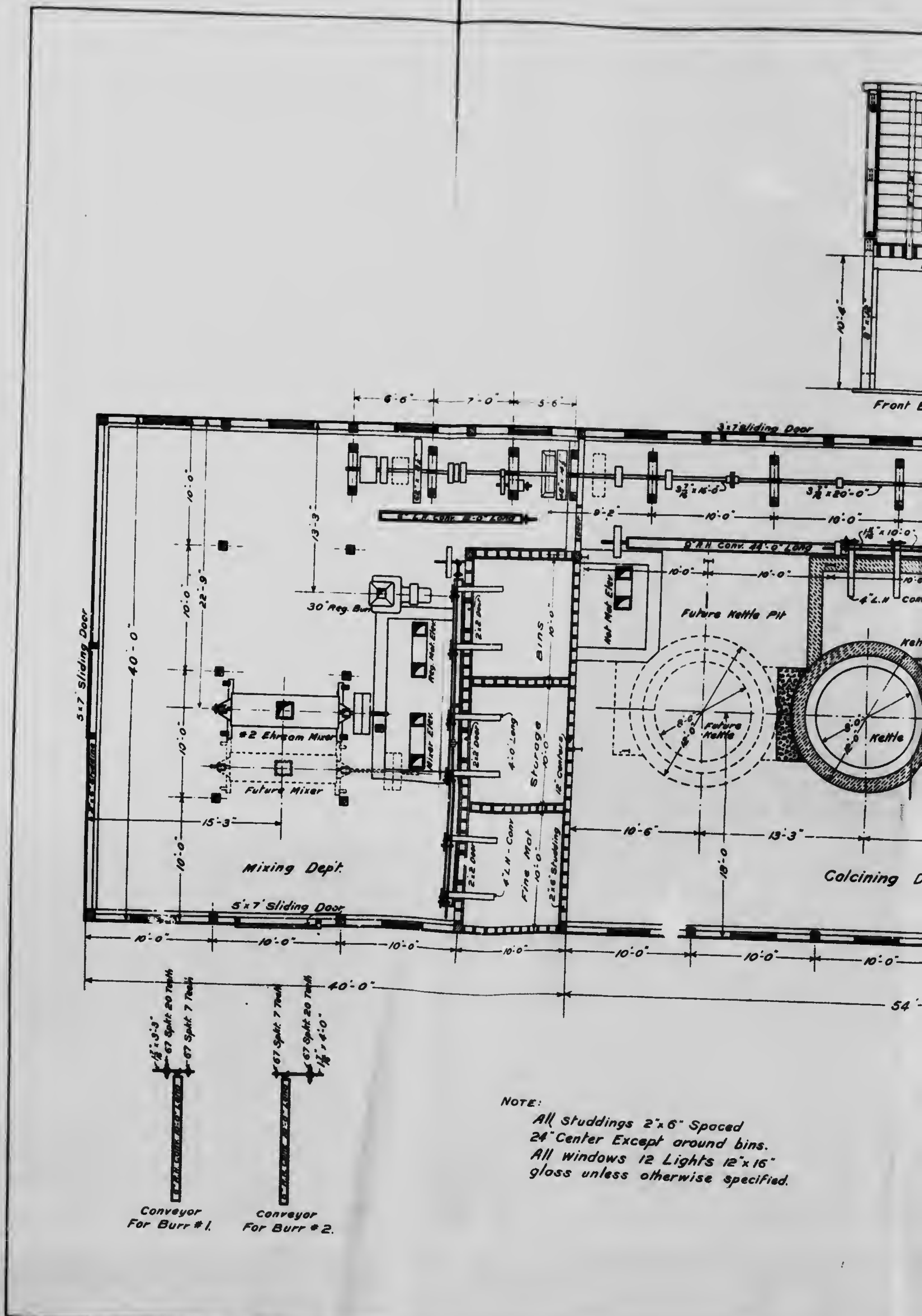


Fig. 5

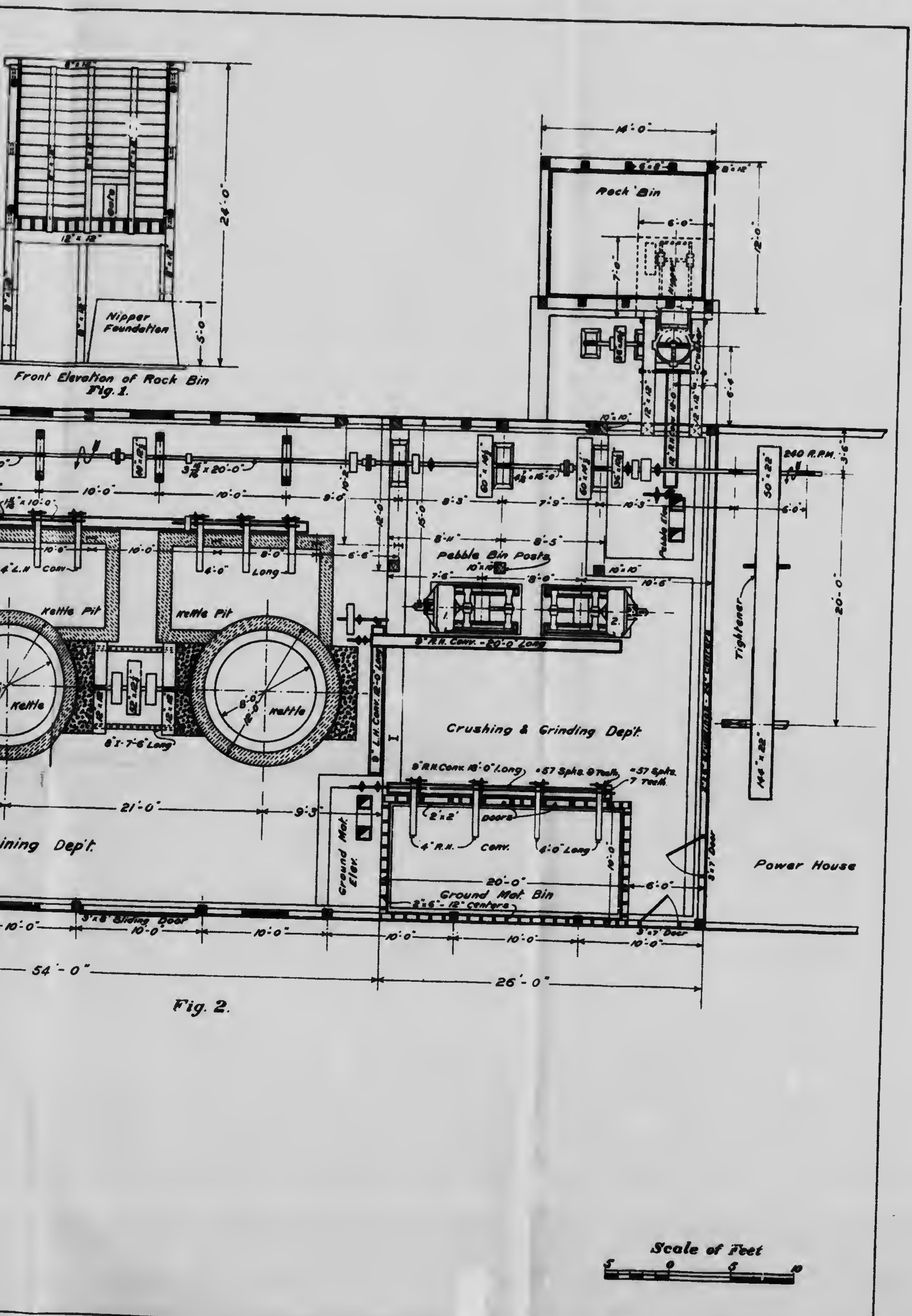
Scale of Feet

…Y KETTLE PLASTER MILL

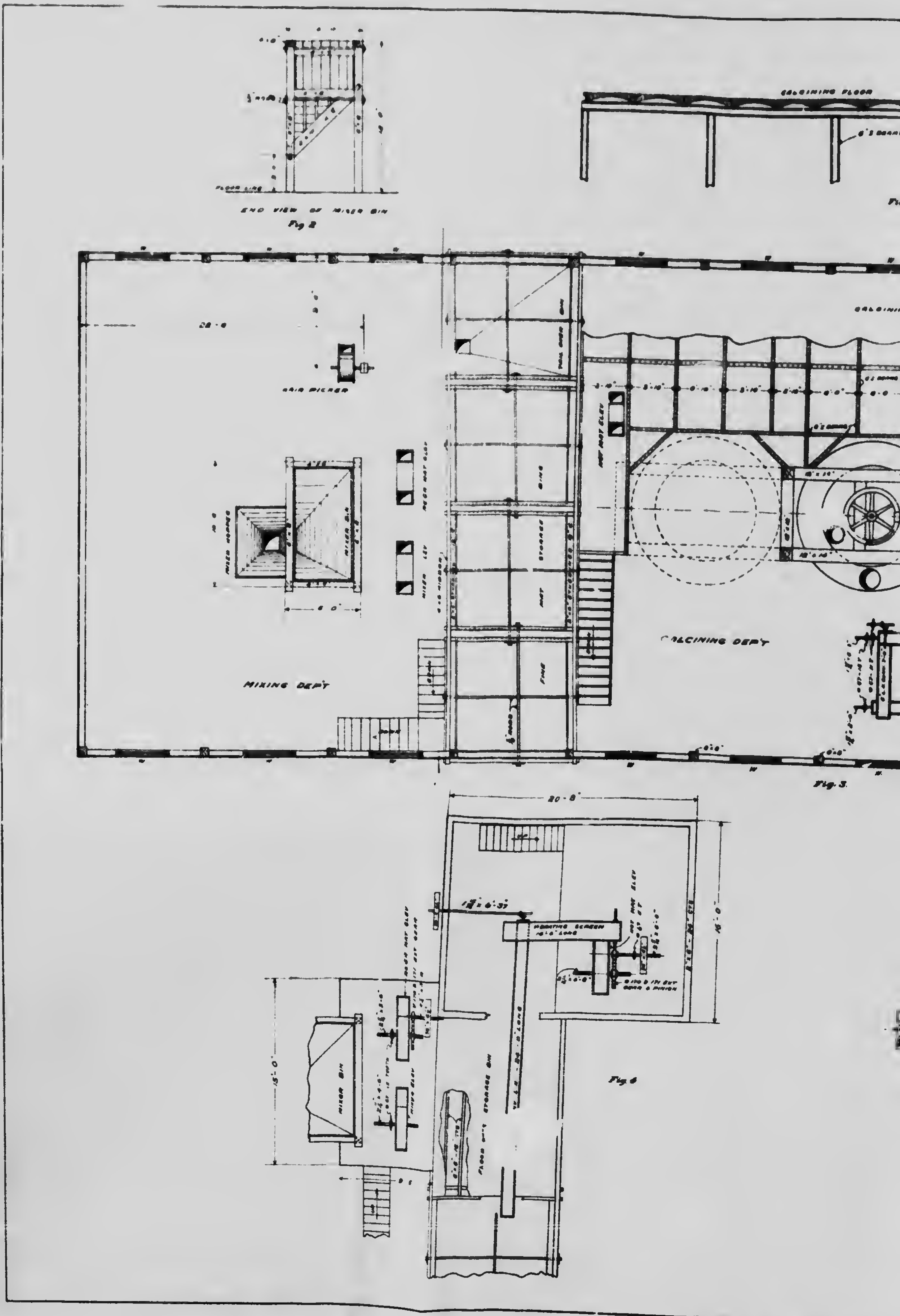


2-8'-0" X 8'-0". KETTLE PLAST

FIG. 9

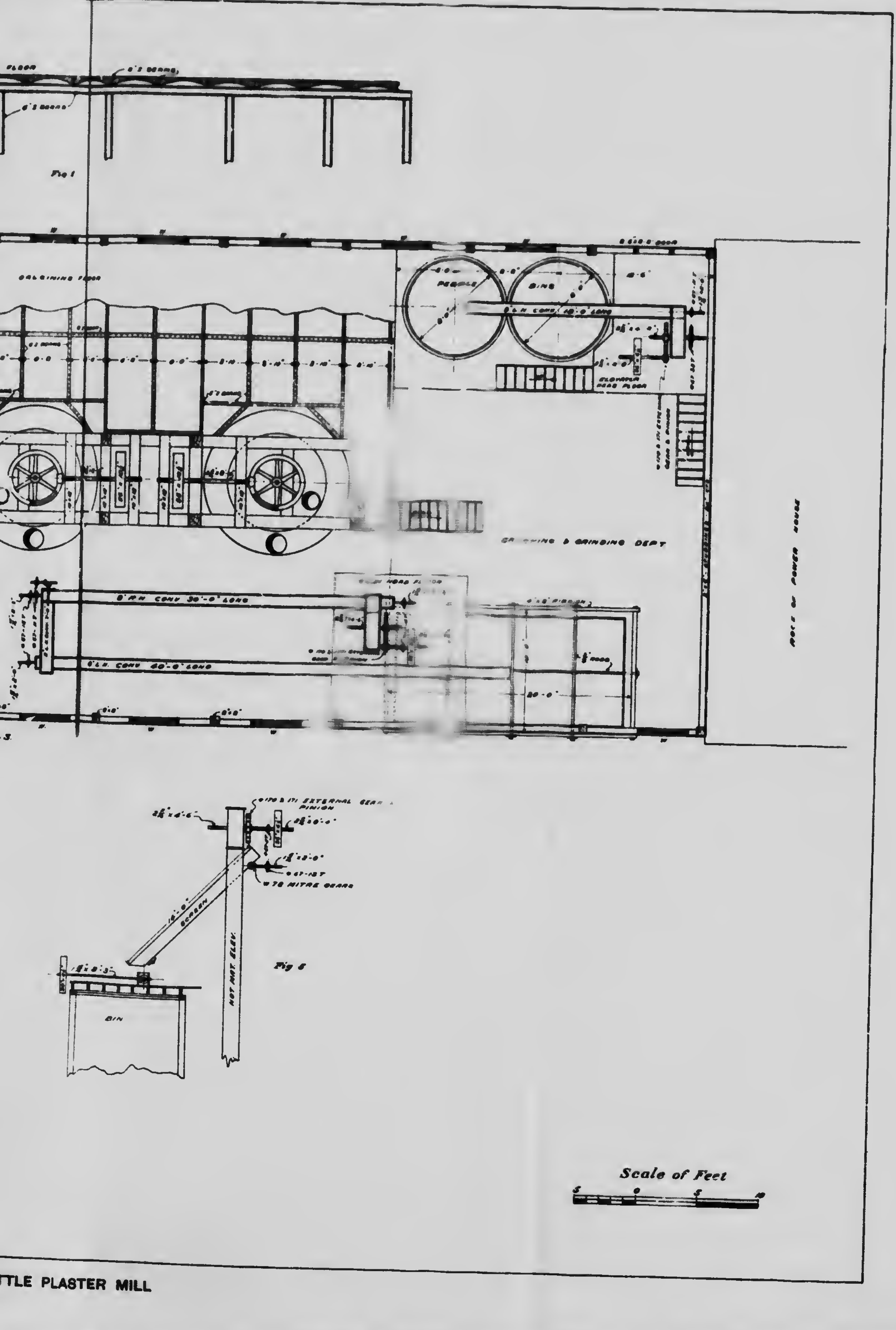


LE PLASTER MILL



2-8'-0" X 8'-0" KETTLE PLA

FIG. 10



...TTLE PLASTER MILL

PLANS, SPECIFICATIONS, AND COST OF CONSTRUCTION FOR PLASTER MILLS.

The information in the following pages is for the construction of mills using the kettle process. The costs given approximate the true costs, as near as possible, without knowing the exact location and local conditions. The first two buildings are designed for wood construction, and details of quantities and size of timber can be obtained from the accompanying plans. The quality of timber to be good, sound spruce, or hemlock.

(1.) Design for plaster mill, having a capacity of 25 tons in 24 hours, shown in detail by two figures, including ten detailed figures.

Figure 7.

Fig. 1. Shows ground plan, with dimensions of building and layout of machinery.
2. Section through calcining department.
3. Second floor plan.
4. Section through grinding department.
5. Third floor plan.

Figure 8.

Fig. 1. Longitudinal section of mill.
2. Section through mixing department.
3. Section through power house.
4. Outside appearance of building.
5. Outside appearance of building.

The machinery consists of the following:—

One 6 ft. × 6 ft. calcining kettle.
" 20″ Ehrsam vertical green-grinding burr mill.
" 20″ Ehrsam vertical regrinding burr mill.
" 20′ Ehrsam rotary crusher.
" Special enterprise noiseless mixer.

Necessary elevators, conveyers, power transmission, and kettle pit feeders for the automatic handling of material from crusher to mixer.

All power transmission material, elevators, and conveyers are of extra heavy and durable pattern.

Power required to run plant, 60 horse-power.

Cost of special machinery..	$1,120
Cost of elevators, conveyers, power transmission, and kettle pit feeders..	834
Approximate cost of building and bins complete, including masonry, and cost of erection..	4,000
Approximate cost of power plant, consisting of one simple slide valve engine, one tubular boiler and counexions..	800
Approximate cost of plaster mill complete..	$6,754

Capacity of the above described plant is 25 tons of finely ground plaster in 24 hours.

On dry gypsum 80 per cent product will go through 100 mesh.

(2.) Design for plaster mill having a capacity of 100 tons in 24 hours, shown in detail by three figures, including eleven detailed figures.

Figure 9.

Fig. 1. Front elevation of rock bin.
2. Ground floor plan, with size of building, and general layout of machinery. It also shows the opportunity for increasing the capacity of the mill, if required in the future, by the addition of another kettle.

Figure 10.

Fig. 1. Construction of calcining floor.
2. End view of mixer bin.
3. Second floor plan.
4. Floor over storage bins with detail of machinery.
5. Arrangement in detail of hot material elevator and screen.

Figure 11.

Fig. 1. Section through crushing and grinding departments.
2. Section through calcining departmert.
3. Section through mixing department.
4. Section through mixing department.

The machinery consists of the followin. –

Two 8 ft. × 8 ft. calcining kettles.
Two 36" Ehrsam vertical green-grinding burr mills.
One 36" Ehrsam vertical regrinding b mill.
One 15" × 22" Ehrsam jaw crusher.
One 20" Ehrsam rotary crusher.
One No. 2 Enterprise noiseless mixer.
One Ehrsam hair picker.
One 21" × 14'-0" vibratory screen

Necessary elevators, conveyers, power transmission, bins, and kettle pit feeders fo the automatic handling of material from crusher to mixer.

All power transmission, elevators, and conveyers are of extra heavy and durabl patterns.

Power required to run plant, 150 horse-power.

Cost of special machinery..	$ 5,115
Cost of elevators, conveyers, and power transmission, bins, and kettle pit feeders..	2,385
Approximate cost of bins and building complete, including masonry and cost of erection..	14,000
Approximate cost of poww replant, consisting of one 16" × 36" Corliss engine, one 72" × 18 ft. high pressure boiler, pumps and connexions..	3,000
Approximate cost of plaster mill complete..	$24,500

Capacity of above described plant is 100 tons finely ground plaster in 24 hours On dry gypsum 80 per cent of product will go through 100 mesh.

(3.) Design for plaster mill, having a capacity of 200 tons in 24 hours, is shown in detail by one figure, including eight detailed figures.

Figure 12.

Fig. 1. Section through power house.
2. Section through grinding department.
3. Section through calcining department.
4. Section through mixing department.
5. Ground plan showing size of building and arrangement of machinery.
6. Longitudinal section of mill.
7. Section through warehouse.
8. Flow sheet.

The building and bins are designed for steel construction, and to be fire-proof throughout.

The machinery consists of the following:—

Two 8 ft. × 10 ft. calcining kettles.
Two 8 ft. × 10 ft. calcining kettles.
Five 42" horizontal Ehrsam burr mills.
Three Morscher-Ehrsam classifiers.
One 22 × 28 Ehrsam jaw crusher.
One 36" Ehrsam rotary crusher.
Three No. 2 Enterprise noiseless mixers.
Two vibratory screens, 21" wide by 8'-0" long.

Necessary elevators, conveyers, power transmission, and kettle pit feeders for the automatic handling of material from crusher to mixer.

Five 36" vertical Ehrsam burr mills may be installed instead of the 42" horizontal burr mills, if so desired.

All power transmission material, elevators, conveyers, and kettle pit feeders are of extra heavy and durable pattern, and cost of repairs, labour, and fuel for operating this plant is reduced to a minimum.

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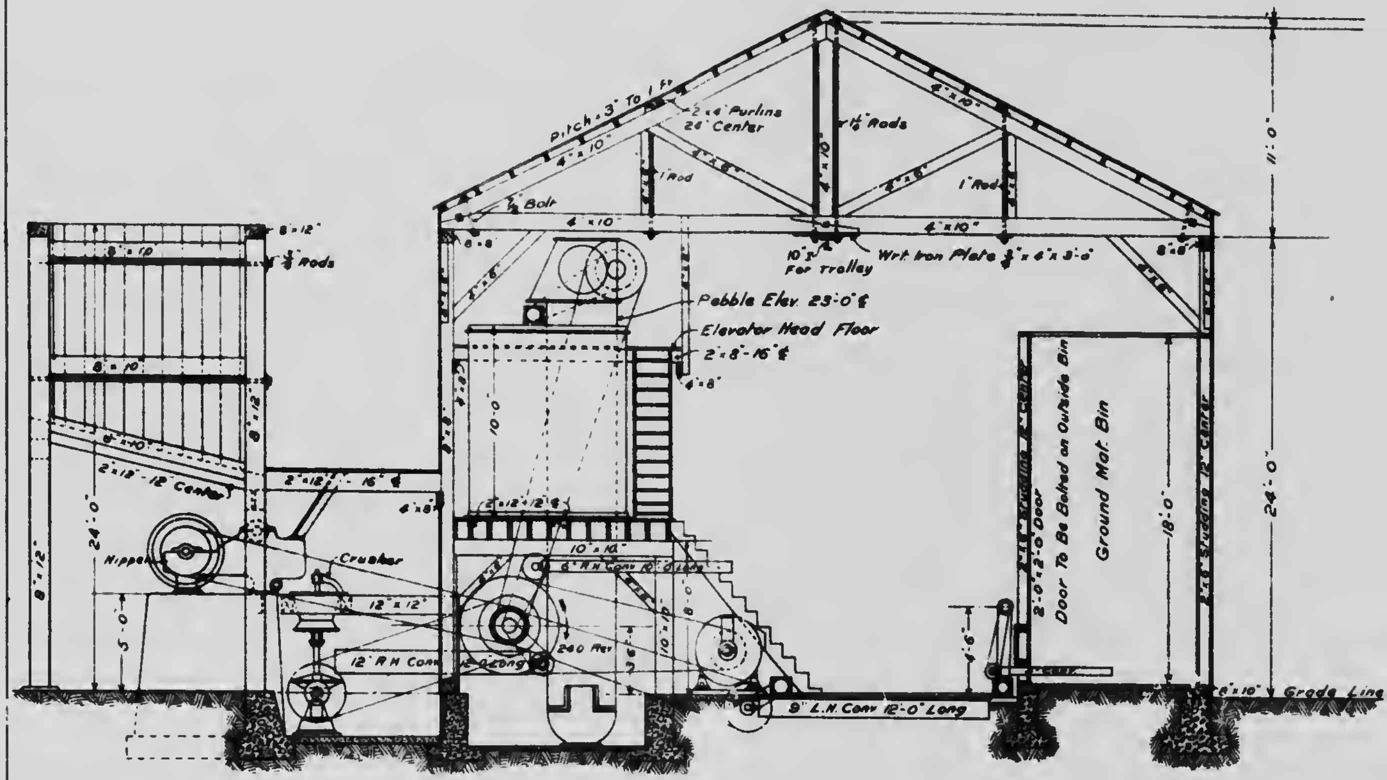
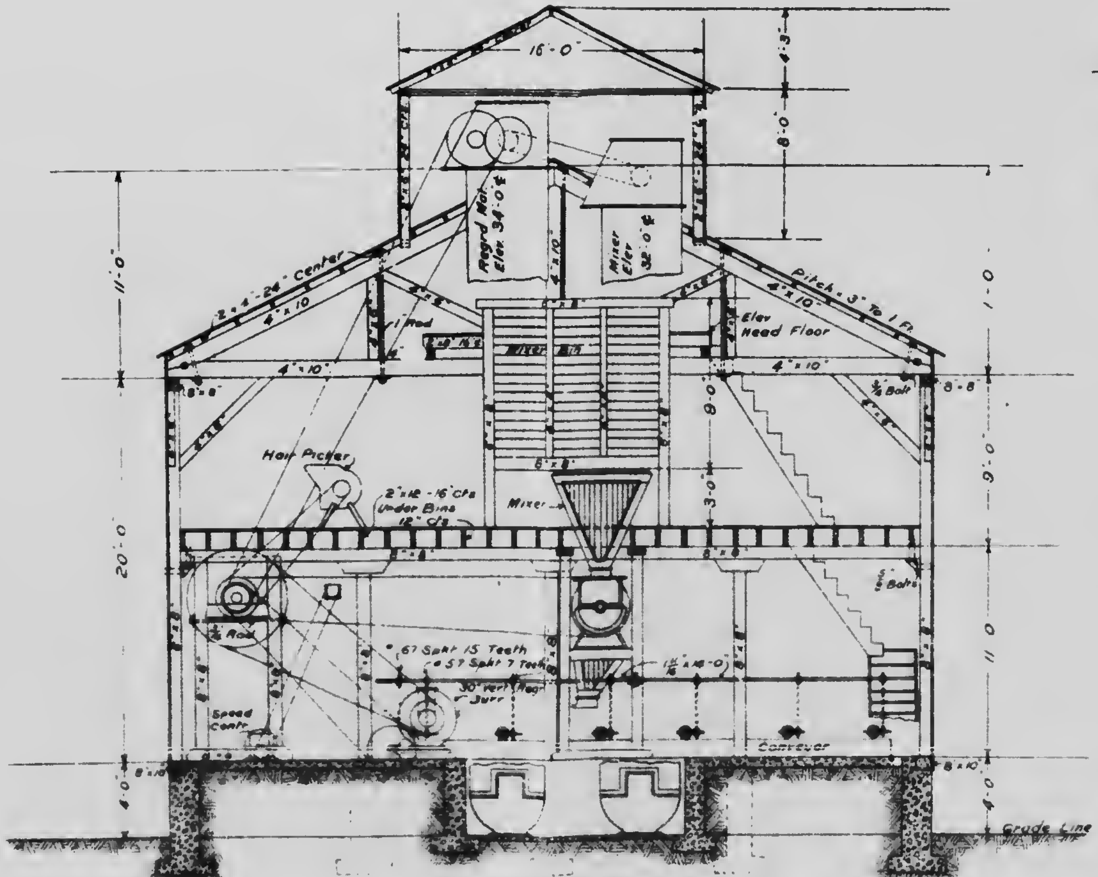
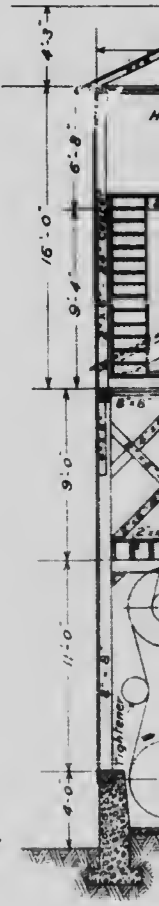


Section Through Crushing & Grinding Dep't.
Fig. 1.

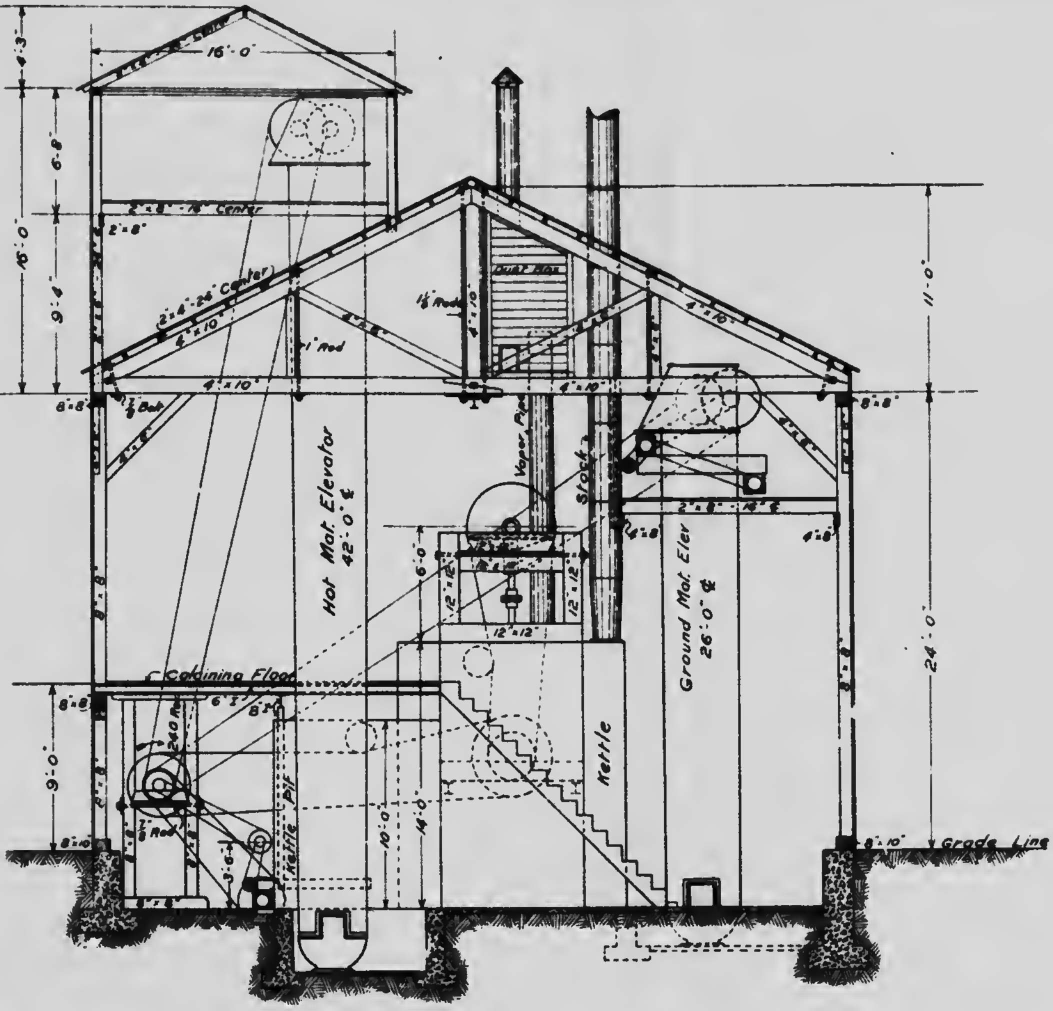


Section Through Mixing Dept.
Fig. 3

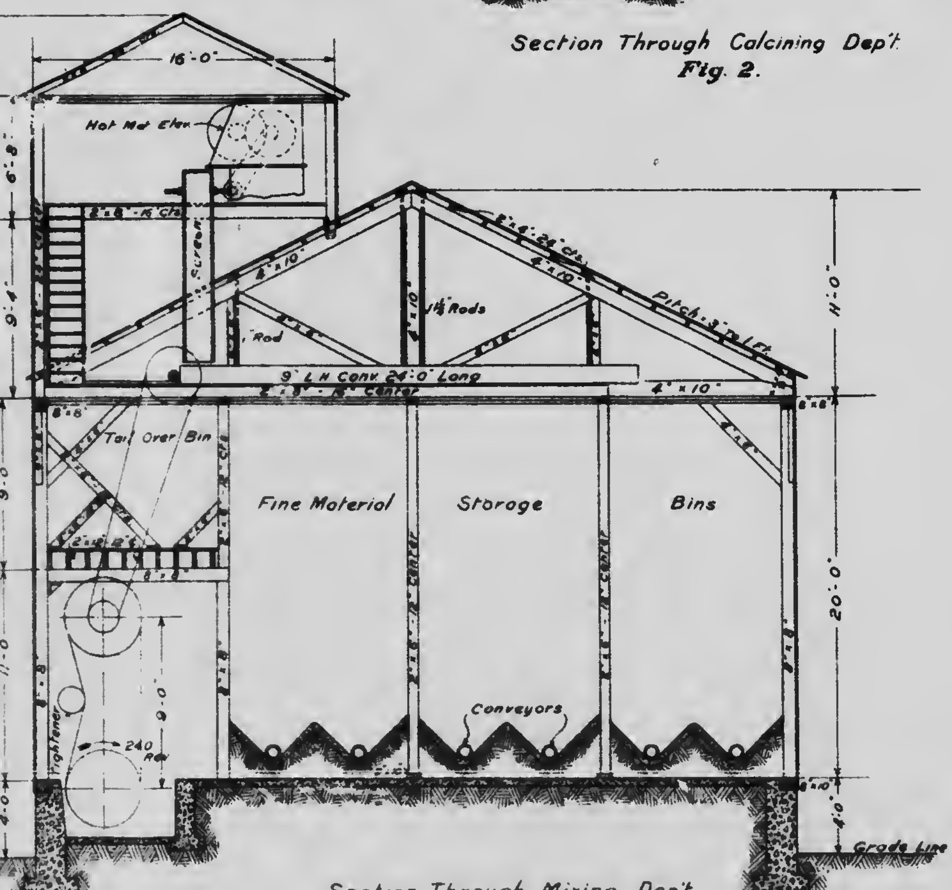


2-8'-0" X 8'-0" KETTL

FIG. 11



Section Through Calcining Dep't
Fig. 2.

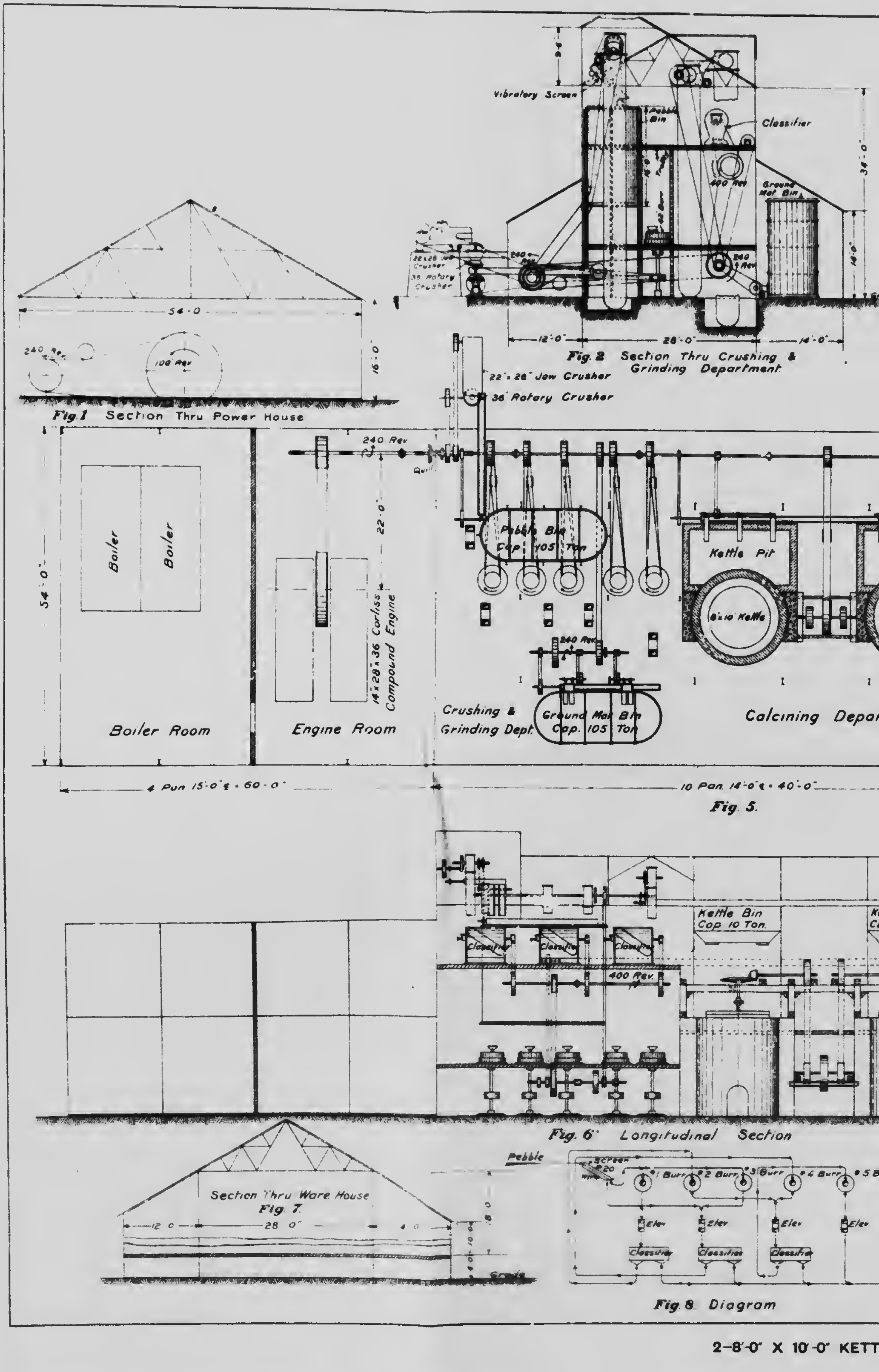


Section Through Mixing Dep't
Fig. 4.

Scale of Feet

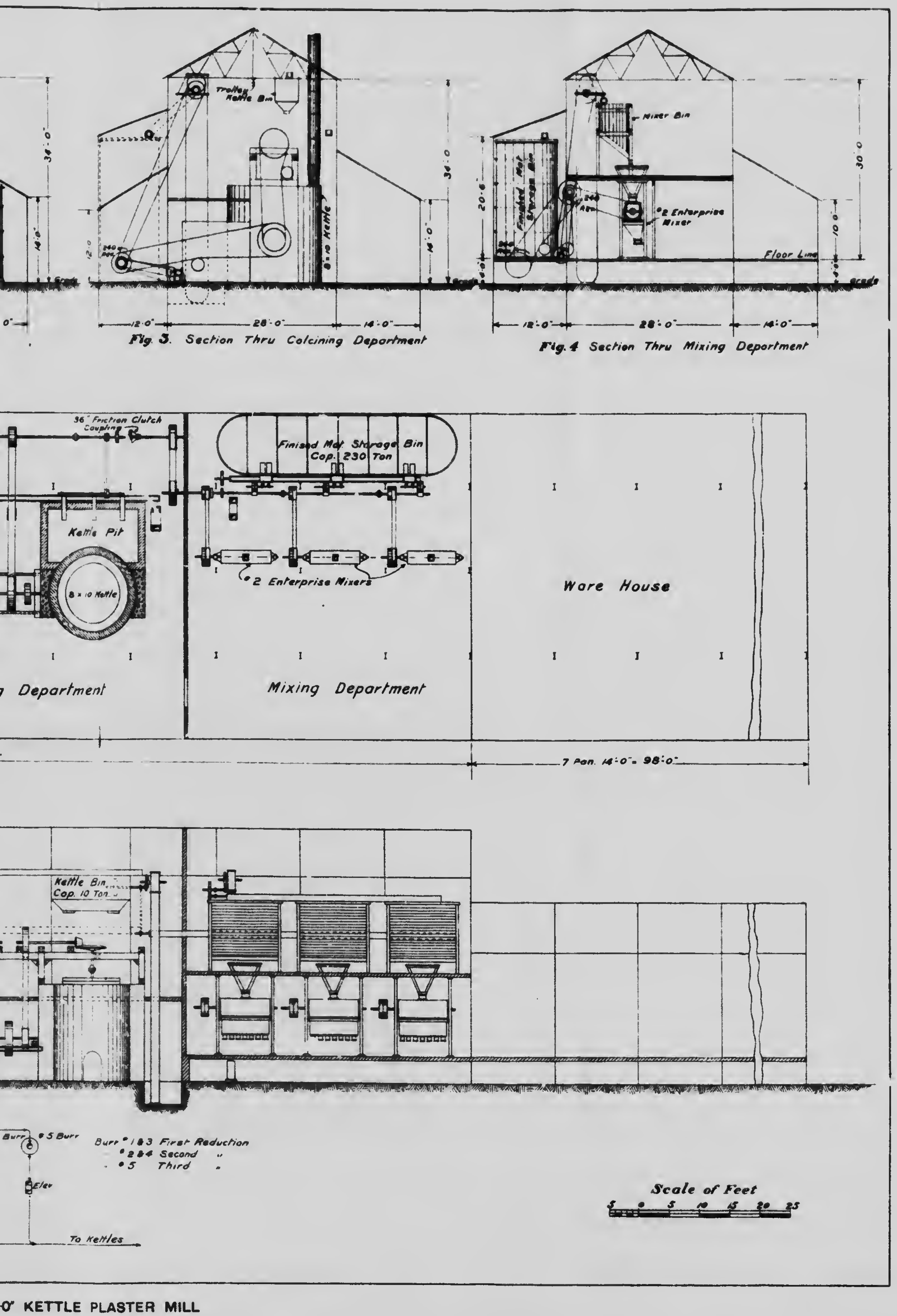
5 0 5 10

KETTLE PLASTER MILL



2–8'-0" X 10'-0" KETT

FIG. 12



-0' KETTLE PLASTER MILL

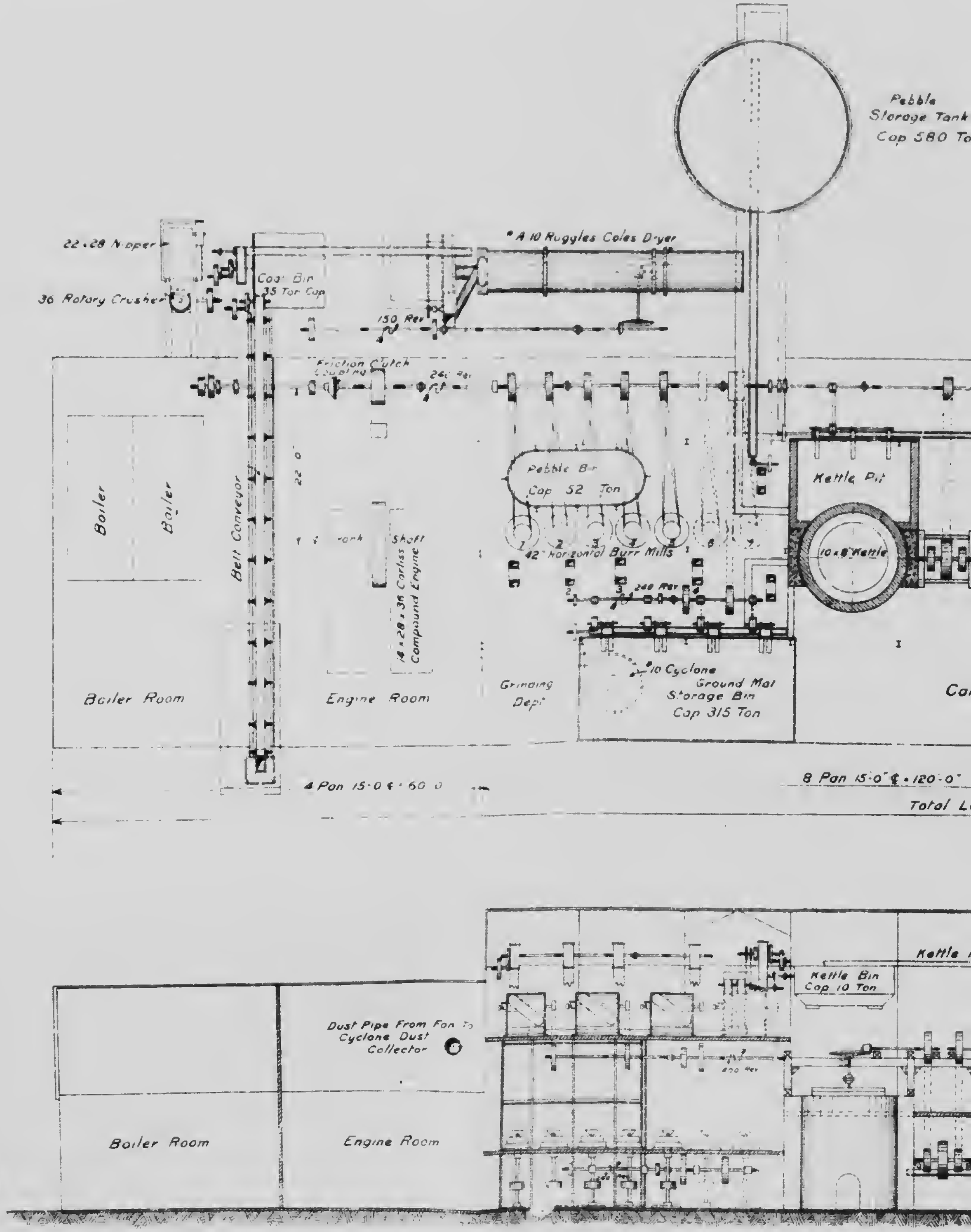
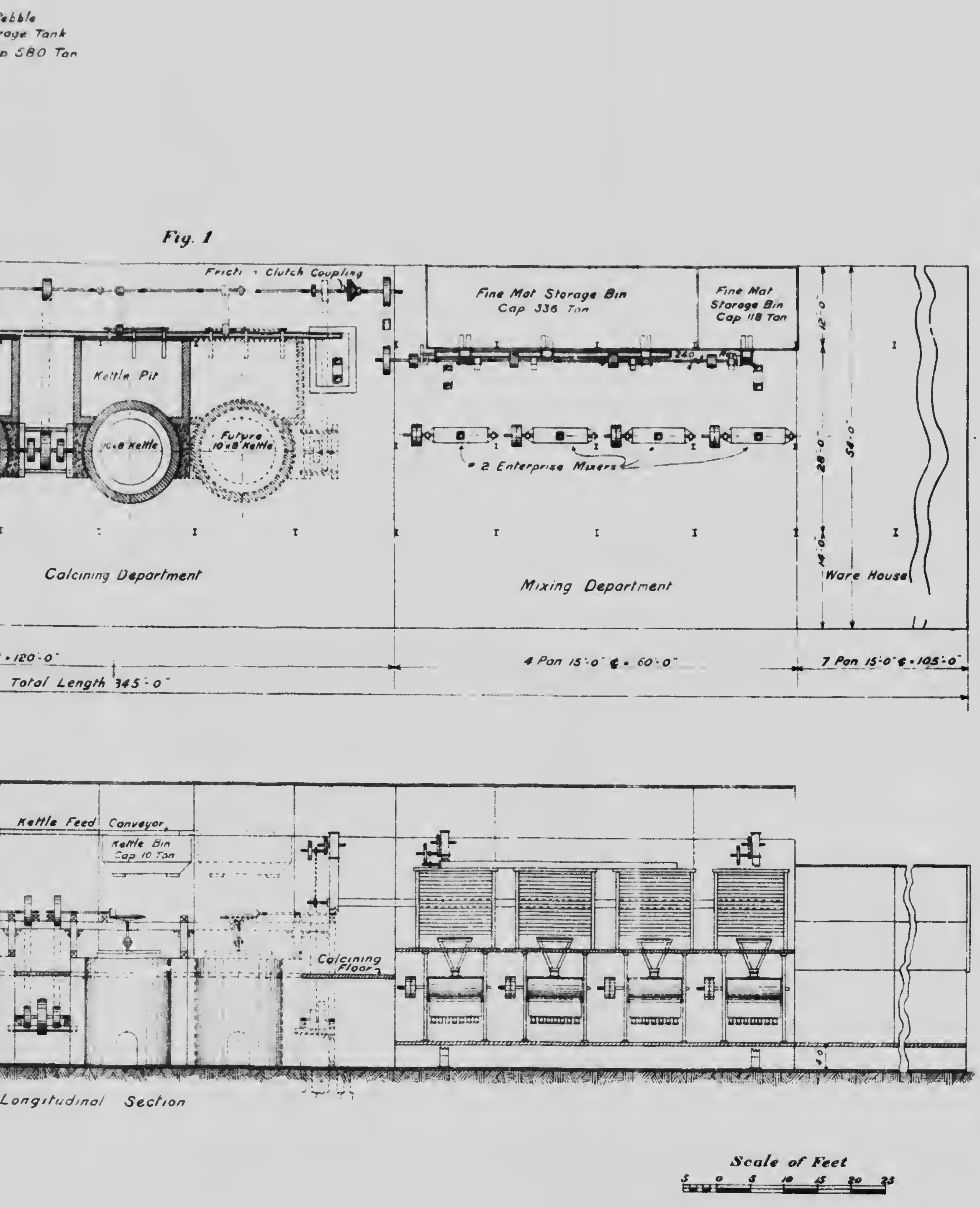


Fig. 2 Longitud

3–8'-0" X 10'-0" KET

FIG. 13



0'-0" KETTLE PLASTER MILL

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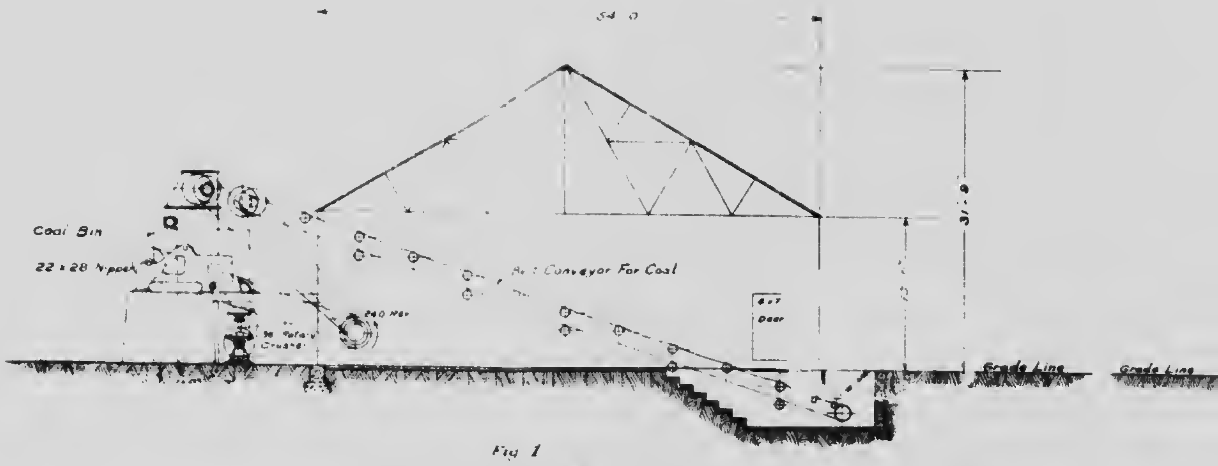

Fig 1
Section Thru Power House & Crushing Dept

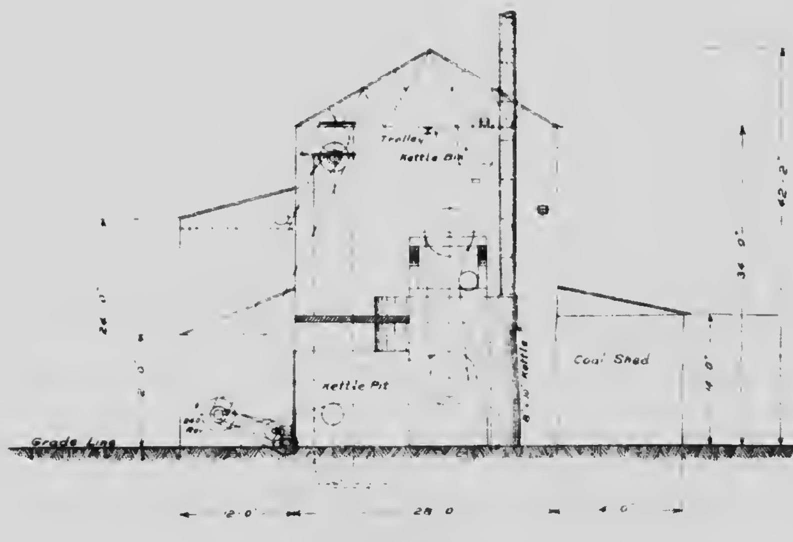

Fig 3
Section Thru Calcining Dept

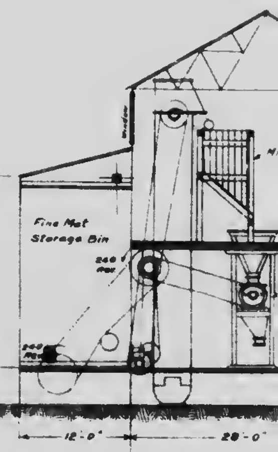

Fig. 4
Section Thru M

Note
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Diagram Showing Flow of Materials From Crushers To Kettles Fig 6

3-8'-0" X 10'-0" KETTLE

FIG. 14

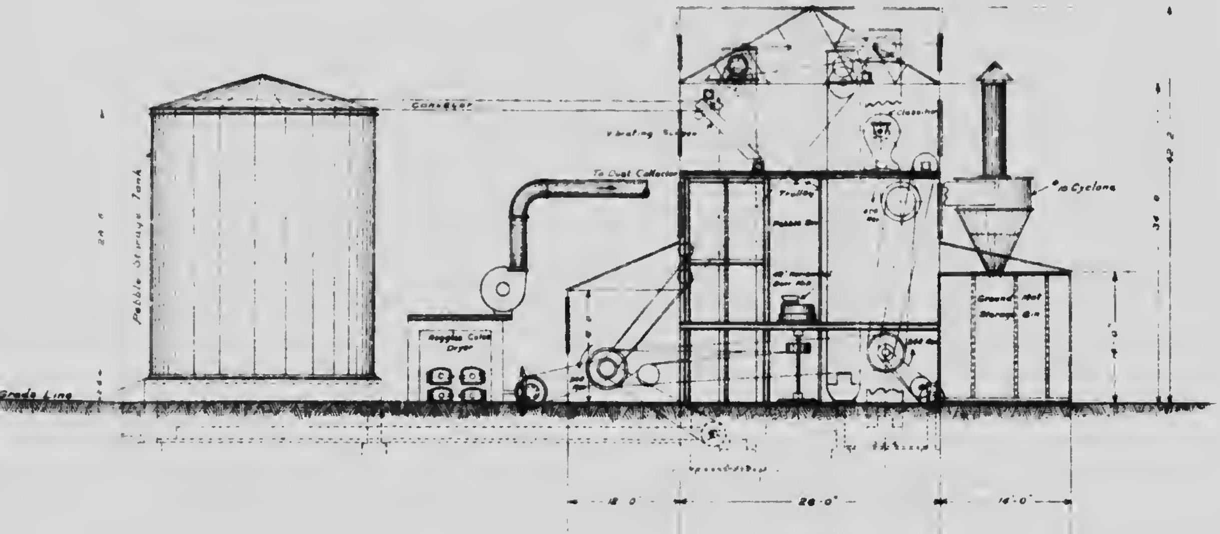

Fig 2
Section Thru Grinding & Drying Dept

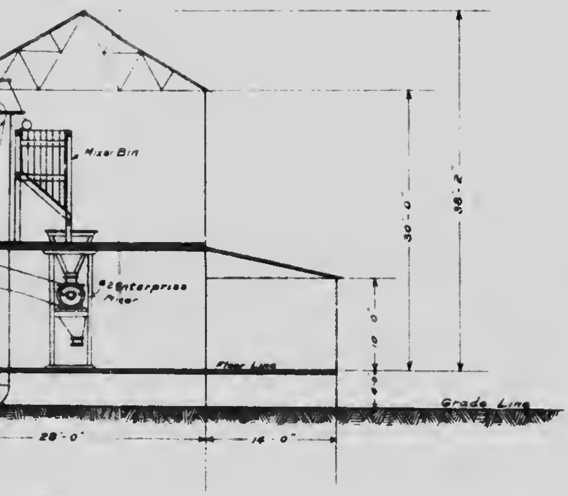

Fig. 4
ion Thru Mixing Dept.

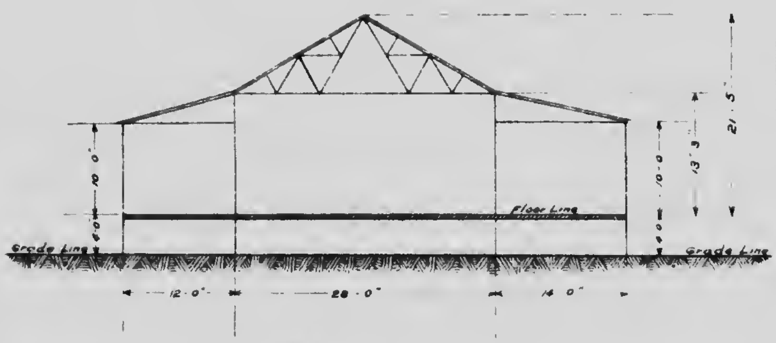

Fig. 5
Section Thru Ware House

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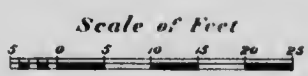
Dotted Lines Show Flow
When Future Machines
Are Installed

To Kettles



KETTLE PLASTER MILL

Power required to run plant, 300 horse-power.

Cost of special machinery..	$ 8,685
Cost of elevators, conveyers, bins, and kettle pit feeders and power transmission..	4,386
Cost of steel buildings and bins complete	17,554
Concrete and brickwork for setting machinery..	2,050
Woodwork and millwright timber..	1,260
Millwright labour, superintendence and erection of machinery..	3,000
Approximate cost of power plant, consisting of two 72" × 18 ft. high pressure boilers, one 14" × 28" × 36 high speed Corliss engine, pumps and condenser, cooling tower, fixtures, fittings, piping, and erection..	10,000
Approximate cost of plaster mill complete..	$46,93.

The capacity of the above described plant is 200 tons finely ground plaster in 24 hours. On dry gypsum 95 per cent of product will go through 100 mesh.

(4.) Design of plaster mill, having a capacity of 300 tons in 24 hours, is shown in detail by two figures, including eight detailed figures.

Figure 13.

Fig. 1. Plan of ground floor, with size of building and arrangement of machinery.
2. Longitudinal section of same.

Figure 14.

Fig. 1. Section through power-house.
2. Section through grinding and drying department.
3. Section through calcining department.
4. Section through mixing department.
5. Section thrugh warehouse.
6. Diagram showing flow of material from crushers to kettles.

The building and bins are designed to be constructed of steel, and the plant to be fireproof throughout.

Three 8 ft. × 10 ft. calcining kettles.
Seven 42" horizontal Ehrsam burr mills.
Four Morscher-Ehrsam classifiers.
One 22 × 28 Ehrsam jaw crusher.
One 36" Ehrsam rotary crusher.
Four No. 2 Enterprise noiseless mixers.
Two vibratory screens, 21" wide by 9'-0" long.
One No. 10 'A' Ruggles-Coles dryer.
One No. 10 cyclone dust collector.

Necessary elevators, conveyers, power transmission, bin, and kettle pit feeders for the automatic handling of material from crusher to mixer.

Seven 36" vertical Ehrsam burr mills may be installed instead of the 42" horizontal burr mills, if so desired. All power transmission material, elevators, conveyers, bin, and kettle pit feeders are of extra heavy and durable pattern, and cost of repairs, labour, and fuel for operating this plant is reduced to minimum.

The Ruggles-Coles dryer shown in this plant is beneficial in reducing cost of grinding, where material comes from quarries wet and containing from 5 per cent to 10 per cent free moisture.

Power required to run this plant, 400 horse-power.

Cost of special machinery, not including dryer and cyclone dust collector..	11,810
One Ruggles-Coles dryer and cyclone dust collector..	3 200
Cost of power transmission, elevators, conveyers, bins, and kettle pit feeders..	7,354
Steel buildings, bins, and pebble storage tank erected complete	21,520
Woodwork and millwright timber..	1,336
Millwright labour, superintendence, and erecting machinery..	4,200

Approximate cost of power plant consisting of the following: —

Three 72" × 18 ft. high pressure boilers, one 16" × 32" × 36" high speed Corliss engine, pumps and condenser, cooling tower, fixtures, fittings, piping, and erection..	15,000
Approximate cost of plaster mill complete..	$64 420

The capacity of the above described plant is 300 tons finely ground plaster in 24 hours. On dry gypsum, 95 per cent of product will go through 100 mesh.

CHAPTER VII.

Products of Gypsum.

The greater part of the gypsum produced is manufactured by grinding, a partial or complete calcination, into various plasters or plaster cements, su as plaster of Paris, stucco, cement plasters, hard-finish plaster, flooring plast etc.

These have been conveniently classified by Eckel, in Cements, Limes, a Plasters, as:—

A. Produced by the incomplete dehydration of gypsum, the calcinati being carried on at a temperature not exceeding 400° F.

(1.) Produced by calcination of pure gypsum, no foreign materials bei added either during or after calcination. ....Plaster of Par

(2.) Produced by the calcination of gypsum containing certain natural purities, or by the addition to a calcined pure gypsum of certain materia which serve to retard the set of the product. ....Cement pla

B. Produced by the complete dehydration of gypsum, the calcination b ing carried on at temperatures exceeding 400° F

(3.) Produced by the calcination of pure gypsum. ....Flooring plast

(4.) Produced by the calcination, at a red heat or over, of gypsum, to whic certain substances (usually alum or borax) have been added. . .Hard-finish plaste

Gypsum is also used in the manufacture of Portland cement, as a retarde either as crude gypsum, as calcined plaster, or as dead-burned (anhydrous plaster. Considerable quantities are ground without calcining and used a land plaster or fertilizer, while smaller quantities are used in the manufacture of paint and paper, and as an adulterant in foodstuffs. The pottery and glass works are large consumers of the calcined product.

It is also used with wines, to retard fermentation and prevent the formation of too much free acid; also to absorb water and strengthen the product.

The pure translucent massive form known as alabaster is used by sculptors for ornaments, while more or less successful attempts have been made to harden gypsum blocks for the interior finish of public buildings. It has been used for several years as a sulphurizing and basic flux in several smelting operations. It may also be worthy of note that it is claimed that the superiority of certain English beers is attributed to the presence of calcium sulphate (gypsum) in the natural water used for their manufacture.

According to the analyses reported by Medcalfe[1] the Burton water contains 24.499 grains of calcium to the imperial gallon, combined principally as

[1] Trans. Fed. Inst. Min. Eng., Vol. XII. p. 112.

calcium sulphate. To produce a similar water to the above for the manufacture of beers in England it is claimed that 350,000 pounds of gypsum are used annually.

PLASTER OF PARIS.

Calcined plaster is a general term applied to all plasters produced at a temperature not exceeding 400° F., in which no foreign material has been introduced. If this article is manufactured from a pure gypsum it is a plaster of Paris, or stucco, which is almost synonymous, the latter being usually manufactured from a fairly pure gypsum, but not quite so finely ground.

The finer grades of this product are very quick-setting, and are sold for dental and surgical work, and for plaster casts and moulds. It is also used for the finishing coat on interior walls of buildings. Dental and surgical plaster is usually reground and carefully sifted so as to give a superfine plaster, free from any grit.

CEMENT PLASTER.

Although plaster of Paris, and cement plasters, are essentially different in their properties and uses, yet their process of manufacture is very similar.

As has been noted, plaster of Paris is manufactured from the purest gypsum, and is quick-setting, while cement plasters are slow in setting, being manufactured from a naturally impure rock, or by adding some substance, known as a retarder, to the material during or after its manufacture. There is also a slight difference in the calcining temperature, which in plaster of Paris is somewhat lower than that of cement plasters.

Where plaster of Paris ordinarily sets in from five to fifteen minutes, cement plaster, by the addition of retarders, may be held back from 2 to 24 hours.

Cement plasters are fast replacing the old time lime plaster, for the interior construction of buildings. In the United States the ratio is about 9 to 1 in favour of cement plaster. Less than 20 years ago this was practically reversed.

It being a good non-conductor of heat it becomes very valuable in the construction of fireproof structures.

When used in the construction of fireproof partitions in buildings the material is usually mixed with wood or cocoanut fibre, and moulded into blocks, 30″ long, 12″ wide, and when solid, 2″ thick. They are sometimes cored, that is having two or three holes through them longitudinally; in such cases the blocks are made 3″ thick.

Studding is also made of this mixture, being cast 3″ square over a core of wood. This wood is generally used in two separate 1″ × 2″ strips. In constructing a partition with this studding a plate and sill, of the same material and size, are used, and also a horizontal row of bridging about midway between plate and sill. All the ends are fastened by a socket specially made from No. 12 galvanized iron to fit over the studding, and through which the nails are driven.

On this studding either the expanded metal or woven wire lath can be used, and the usual coats of plaster put on to finish, or a board manufactured from the same material can be used instead of the laths. The construction of this is shown in Fig. 15, detailed figures 1 and 2. The figure (a) shows the socket used in fastening the ends.

Some manufacturers, instead of using wood or cocoanut fibre, have substituted sawdust and rushes. Mr. Wilder, in Vol. XII of the Geological Survey of Iowa, gives a very good description of the method of manufacturing these plaster boards.

'Calcined plaster is mixed with water, and a certain amount of sawdust. On an iron table, with a heavy iron top, are laid iron strips, which have a thickness equal to that intended for the gypsum boards. The space enclosed by these strips also determines the length and breadth of the board. Within this space are scattered excelsior, and rushes, and over these is poured the gypsum, water, and sawdust mixture. The rushes and excelsior are carefully worked into the middle of the mass by hand. An iron bar is drawn over the top of the strips, leaving the surface of the mass either smooth or ridged. It is allowed to stand about five minutes, and then the iron table on which the mass rests is struck vigorously two or three times with a heavy mallet. This loosens the gypsum board from the iron plate and strips. A workman takes it on his shoulder and carries it to an open shed, where it stands on end until dried by natural heat. The length of time required for drying depends wholly on the atmospheric conditions. Artificial heat for drying gypsum boards has proven very unsatisfactory, as the boards so dried crumble readily on exposure to the air. The weight of gypsum boards 2·5 centimetres thick is about 50 pounds per square metre, and for boards 8 centimetres thick about 120 pounds.'

Other manufacturers use thin cotton cloth in alternating layers with the plaster in making boards. These boards, and the studding when finished and dried, may be cut or sawn in lengths or size required. Interior partitions or walls constructed with either these blocks, or the studding and boards, can be considered fireproof, and stand the most rigid tests.

The following report, furnished by the United States Gypsum Company, shows the results of a fire and water test on a building constructed of material similar to the above, manufactured by them.

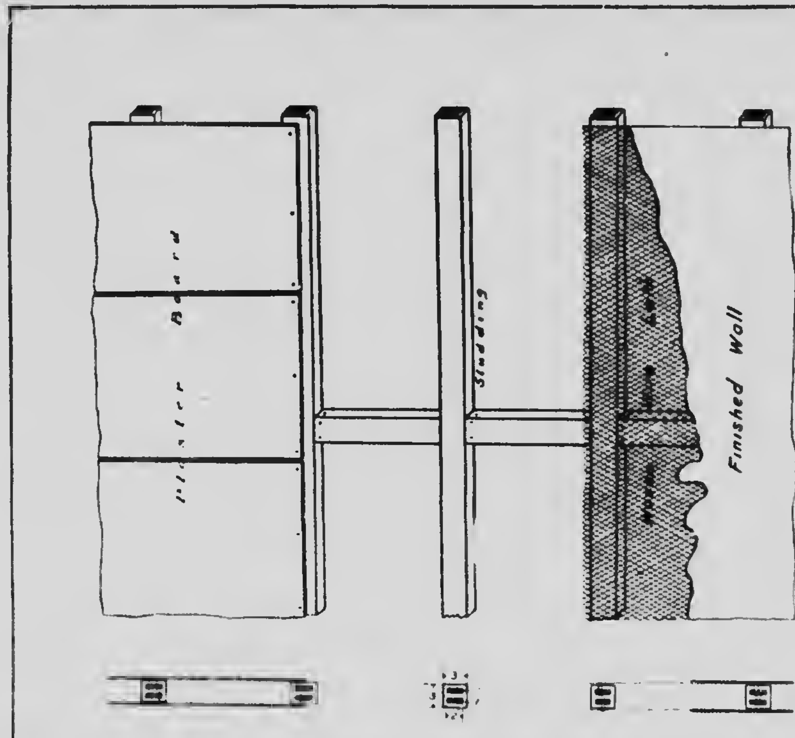
REPORT OF FIRE AND WATER TEST.

This report of fire and water test was made upon plaster block partitions constructed by the United States Gypsum Company, 1,123 Broadway, New York.

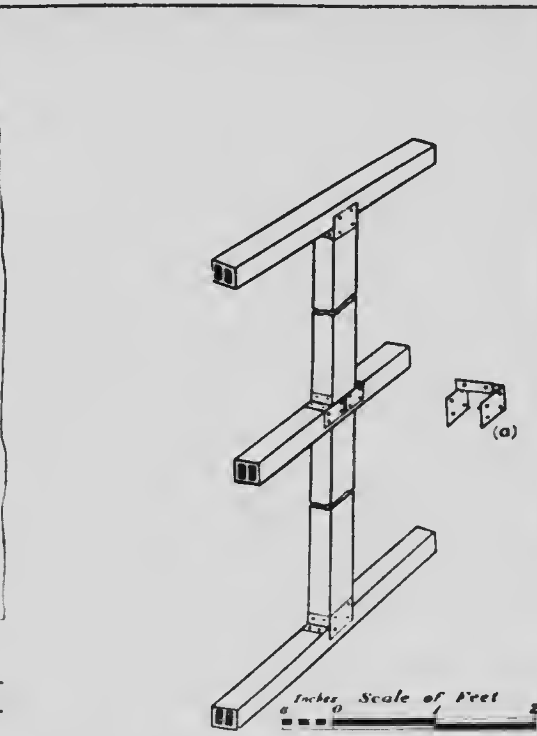
The test was conducted at the fire testing station, Columbia University, 116th Street and Claremont Avenue, New York, on Nov. 6, 1905.

Weather observations showed the day to be damp and cloudy, with light winds from the southeast. Temperature 54° F.

FIG. 15.



View showing fireproof wall of gypsum as constructed by the United States Gypsum Company, Limited.



View showing construction of fireproof studding manufactured by the United States Gypsum Company.

Partitions were constructed on October 18, and the plaster applied on Oct. 19, 21, which made the age of the test on partitions 19 days, and on the plaster covering 17 days.

The test started at 10.54 o'clock, and water was applied at 12 o'clock.

Method of Construction.

The partitions were erected in test house No. 2, which is designed exclusively for partition tests. It is the standard size required by the Building Bureau specifications, viz., 14′-6″ × 9′-6″ on the outside and 9′-6″ from grate to ceiling. The foundation walls are 2′-4″ above the ground level, and upon them the grate is placed. Securely anchored in the walls is a 4″ × 4″ ... angle-iron framework which supports the roof, and to which the walls of building are attached. Suitable draft openings and chimney flues are provided.

The partitions formed the side walls, and they were the only parts ... test. The end walls and roof are of reinforced concrete, and are of permanent construction.

The blocks were made of plaster of Paris mixed with cocoanut fibre. The edges were not grooved. The partitions were formed by building up the blocks. The mortar joints were ⅜″ to ½″ thick. The mortar was a mixture of 'Ivory Cement Mortar.' Both sides of the partitions were given a ½″ coat of 'Ivory Cement Wall Plaster,' which is a product of the same Company. Each partition had an area of about 138 square feet.

Purpose of the Test.

The purpose of the test was to determine the effect of a continuous fire against the partitions for one hour, bringing the heat gradually up to 1,700° F. during the first half hour, and maintaining an average of 1,700° F. during the last half of the test. Then a 1⅛″ stream of water to be thrown against the partitions for 2½ minutes, at hydrant pressure, which at this location varies from 25 to 30 pounds.

Temperature.

The temperature of the fire was obtained by three electric pyrometer couples, one suspended through the centre of the roof, hanging 8″ below the ceiling, and the other two inserted through the partitions at the middle, about 2 feet from the top. Temperatures were read from each couple every three minutes. The log of temperature readings and plotted curve for one couple are herewith attached.

The fuel was dry cord wood and refuse lumber. Frequency of firing was governed by the temperatures recorded.

To measure the heat transmitted through the partitions by conduction, a thermometer was placed on the outside of each partition, with the bare mercury bulb in a slight hole cut in the plaster, and then surrounded by a box to prevent air radiation.

The following table gives the temperature readings:—

Thermometer Readings on Outside of Partitions.

Time in Minutes.	Temperature F.
	Deg
5	51
10	54
15	54
20	56
25	80
30	121
35	156
40	169
45	176
50	181
55	183
60	182

Water.

In applying the water through the door in the end of the building it struck the partitions at an angle, and not with full force. The stream was thrown back and forth over the whole surface of the partitions as much as possible, and not allowed to play continuously on one spot.

Effect of the Test.

Twenty minutes after starting the test a $\frac{1}{16}''$ crack appeared in the middle, and extended from the top to within 18″ of the bottom. It was apparently a shrinkage crack in the outside plaster. At the same time, the partition as a whole bulged inward about 1″.

Five minutes later cracks appeared along the steel frame at the top, and at the corner posts. These gradually opened as the test proceeded. One half hour after the start the partition was bent inwards 1½″ at the middle, the crack along the top had opened ½″, and that along the south corner post ¼″. Diagonal cracks had also developed about 3 feet from each of the lower corners. The maximum deflection inward at the end of the hour's test was 1¾″, but there was apparently no slipping of the blocks at the joints.

The plaster appeared to resist the fire well. With the exception of a few small patches, the inside coat remained in place until the water struck it. The application of water quickly knocked all the plaster off, and washed away the blocks to the middle of the hollow spaces. The fire had calcined the blocks to that depth (about 1½″). No fire, smoke, or water came through the partitions, and they remained firmly in place after the test. As it cooled it gradually went back towards its original position. The final deflection inwards was less than one inch.

The test was made in co-operation with the Bureau of Buildings, and was observed by the following Bureau engineers: Inspector A. Schwartz, borough of

Manhattan; Inspector J. J. Koen, borough of Brooklyn; G. Lester Willi..., manager, and J. Granger Ketchum, represented the U. S. Gypsum Com... Others present were:—M. B. Jewett, Jasper T. Goodwin, Underwriters ... Extinguisher Co.; G. H. Stewart, representing Insurance Engineering; ... P. Enke, Inspector for German American Insurance Company.

Log of Temperature Readings, Fire Test, U.S. Gypsum Company, tested Nov. 6, 1905.

	Time.	Couple No. 1.	Couple No. 2.	Couple No. 3
	10·54			
	10·57	124	124	124
	11·00	235	251	254
	11·03	506	541	[illegible]
	11·06	506	541	[illegible]
	11·09	541	595	524
	11·12	676	759	[illegible]
	11·15	1101	1031	[illegible]
	11·18	1304	1358	1317
	11·21	1448	1516	[illegible]
End of first half of test—	11·24	1529	1580	1516
	11·27	1567	1619	1554
	11·30	1619	1658	1593
	11·33	1645	1684	1671
	11·36	1726	1738	1713
	11·39	1738	1751	1738
	11·42	1763	1776	1776
	11·45	1814	1788	[illegible]
	11·48	1788	1763	1788
	11·51	1713	1726	1751
	11·54	1700	1687	[illegible]
Average temperature during second half of test	......	1707	1719	17..

POTTERY AND TERRA-COTTA.

In the manufacturing of moulds for pottery work, plaster of Paris is extensively used, and for this purpose the Nova Scotia gypsum is particularly well suited. Mr. S. A. Weller, a pottery manufacturer of Zanesville, Ohio, writing to the chairman of the Ways and Means Committee at Washington, D.C., dated Nov. 20, 1908, says: 'We use in the manufacture of moulds considerable plaster which is made from Nova Scotia gypsum, it being the only plaster which makes a satisfactory mould in our work.' For the manufacture of models for terra-cotta, Mr. Saul, of the Atlantic Terra Cotta Company, of New York, writing to the above committee, dated Nov. 24, 1908, says: 'Calcined plaster from the Nova Scotia gypsum is absolutely indispensable.' These industries are important consumers of plaster of Paris in both England and the United States.

PLATE GLASS WORKS.

In manufacturing plate glass, large quantities of plaster of Paris are used for bedding the plates on large circular tables, to be polished. The table is usually a large revolving one, and on it is spread a coating of plaster and the rough glass plate is embedded in it and the first side polished. When this is completed the plate is loosened by breaking away the rough edges. The table is then thoroughly cleaned, and a second covering spread over it. Particular attention is paid to this last coating, to be assured that it is the purest plaster of Paris, and free from any foreign substance that would cause grit and be liable to scratch the already polished surface that is now to be embedded in it.

For this purpose it requires 2,200 pounds of plaster of Paris for each 1,000 square feet of glass.

In some glass factories they have their own calcining kettles, and the set plaster is ground and recalcined to be mixed with fresh plaster, but used only in first polishing.

PLASTER PRODUCED BY COMPLETE DEHYDRATION.

Flooring plaster is included under this classification, being a product of calcination at temperature exceeding 400° C. It is a plaster entirely free from water, and manufactured from the purest gypsum. In manufacturing, the gypsum is not finely ground, but is broken into small lumps and is calcined in vertical kilns by hot gases, usually from coal burned as fuel on a grate at one side of the kilns, the gas passing directly through the mass and raising it to a temperature of 500° C. and maintaining that temperature for not more than four hours. The product must not be considered as dead-burned, as it still has the power of absorbing water, but if it remained in the kiln at the above temperature for more than four hours it would then be dead-burned, as after that time it loses its capacity to bond with water.

In Germany it is manufactured quite extensively, but not in England or the United States, although the latter country imports small quantities annually. It is a very slow setting material, requiring days, and often weeks before the theoretical amount of water is absorbed.

A treatise on the chemical changes involved in the manufacture of this product was published in 1903, by Van't Hoff, in the Transactions of the Berlin Academy of Science, and a translation of it is given by Eckel in 'Cements, Limes, and Plasters.'

HARD WALL PLASTERS.

The materials classed under this heading are, owing to the high temperature at which they are calcined (exceeding 400° F.), slow setting, and owe their hardness to this, and also to the fact that they have been treated by some chemical, as borax or alum, during manufacture.

In this classification are placed a large number of cements which are defined as hard-finish plasters. Some of these are known commercially as 'Keene's Cement,' 'Martin's Cement,' 'Parian Cement,' and 'Mack's Cement.'

Landrin placed crude gypsum in a 10 per cent solution of sulphuric acid for ten or fifteen minutes, and then calcined it, resulting in a cement having a good set and hardness. The temperature required to give the most satisfactory results was found to be between 600° and 700° F.

The most prominent representative of this class of cements was originally manufactured under English patents, and termed Keene's cement. It is made by taking pure gypsum and calcining it at red heat, and then immersing it in a solution of alum. After drying, it is again calcined at a high temperature and ground very finely, when it is ready for the market.

Mr. William M. Dawson, of New York, claims to have discovered a compound that will take the place and serve the functions of the well known Keene's cement, at a much lower cost. In his specification, forming part of his letters patent No. 523658, he gives the following description: 'I take, for example, a quantity of animal or vegetable organic matter and permit it to [illegible] for several days in a proper quantity of water, at a temperature of from 80° to 200° Fahrenheit. When fermentation or decomposition has progressed so that the albuminous and nitrogenous substances have been liberated from the organic matter, and the liquid has turned to a dark watery colour, it is incorporated with a mild lime, or lime partially air-slacked. The incorporation of the lime and liquid has the effect of freeing the ammonia from the liquor. The lime which drives off or frees the ammonia serves as a vehicle for the liquor, and forms the body to be mixed with the cement or plaster. The mass thus obtained is allowed to dry, and to this composition I add two parts of nitrate of soda either before or after drying the mass, or in lieu of this, one part of nitrate of sodium and one part of borax. After the ingredients have been properly incorporated, the mass is thoroughly ground to a powder, for convenient manipulation.'

Martin's cement in preparation is similar to Keene's, but it has pearl ashes added to the alum, and sometimes a small quantity of muriatic acid, also, is added to prevent an alkaline reaction.

Parian cement is made from gypsum hardened by the addition of borax. One part of borax is dissolved in nine parts of water, with sometimes one part of cream of tartar added, and the gypsum treated as above, with that solution.

Mack's cement is dehydrated gypsum, with 0.01 per cent of calcined sodium sulphate added, with which a quick setting and hard durable cement is obtained. By adding potassium sulphate instead of sodium sulphate the same results are reached.

USED WITH PORTLAND CEMENT.

In the manufacture of Portland cement, gypsum in its crude state, or manufactured as plaster of Paris, or as dehydrated plaster, is used as a retarder, and it also has, in small quantities, a beneficial effect in increasing the tensile strength of the cement. It has been shown by laboratory test, and actual practice, that if from 2 to 3 per cent be used, it will give better results than either greater or less quantities. This, at the present rate of cement manufacture in Canada, means a consumption of over 12,000 tons of gypsum annually. The form in which it is used to get the best results is a question open to much discussion, but as a matter of fact, the manufacturers of Portland cement in the United States use it almost exclusively in the crude form.

ALABASTINE.

Alabastine, often called cold water paint, is manufactured from the purest gypsum—ground, calcined, and reground to the finest powder. This extra fine calcined plaster is mixed wth various metallic colours, and with the addition of water may be used for tinting walls. If properly mixed and applied, it will set like wall plaster and will not rub or scale off. It may be applied coat upon coat on any solid surface, as wood, plaster, brick, or iron, with satisfactory results.

Uncalcined gypsum is often used as an adulterant in the manufacture of white lead, where it is claimed to have a beneficial effect. It is also used as an adulterant of various foods and drugs.

In making crayons for blackboards and carpenters use, the ground uncalcined gypsum is used extensively, by mixing it with other ingredients (a secret formula) and pressing to the shape required. One company in the United States, for this purpose uses nearly 1,000 tons of gypsum annually.

AS A BASIS FOR PORTLAND CEMENT.

Attempts have been made to manufacture Portland cement from gypsum and save the sulphur content as a by-product. A few patents have been issued by the United States Government for this operation, but beyond this fact very little seems to have been accomplished.

The method of operation in general has been described as follows:

Gypsum and clay are finely ground and intimately mixed, with the addition of a small quantity of water. The mixture is then moulded into bricks and placed in a suitable kiln, where a high temperature is maintained until the whole is thoroughly calcined. It is claimed that in the process of calcination the silicic acid contained in the clay expels the sulphuric acid contained in the gypsum, leaving the lime, which combines with the alumina of the clay and forms silicates of lime and aluminium. This product, it is claimed, is, when finely ground, in every particular hydraulic cement. The gases escaping during the process of calcination are collected in suitable condensing chambers, and treated in the usual manner practised in the manufacture of sulphuric acid.

AS A SULPHURIZING AND BASIC FLUX.

Gypsum has for many years been used for these purposes, in several smelting operations. In smelting oxide nickel-ore in the blast furnace it is usually added, to furnish the necessary sulphur for collecting the metal in a matte and a base for slagging the siliceous gangue. At Freiberg, Saxony, for years it has been used in the concentration of lead-copper matte in the reverberatory furnace. The latest use it has been put to is in the blast-roasting process of Carmichael-Bradford.

In a paper before the American Institute of Mining Engineers, by H. O. Hofman, and W. Mostwitsch, of the Massachusetts Institute of Technology, entitled 'The Behaviour of Calcium Sulphate at elevated Temperatures with some Fluxes,' the action of gypsum under such conditions is fully explained.

RETARDERS, THEIR COMPOSITION AND USE.

As already noted, plasters produced by the incomplete dehydration of pure gypsum at temperatures not exceeding 400° F. will set in from 5 to 15 minutes.

For construction work this will not give sufficient time for workmen to complete their operations, and particularly for this purpose the retarder has been introduced.

Just what chemical action takes place, or what influence the retarders have on the crystallization of calcined plaster is a matter of speculation, and not satisfactorily explained.

It does, however, in some way delay the formation of the crystal net-work to which the set of plaster is due, and this in proportion to the amount of retarder used. Many and varied are the compounds that have been introduced for this purpose. In the ancient days, the Romans used blood to retard the set of plasters, and at the present time the organic refuse from the slaughter house is found to produce the desired effect. In earlier times a solution of glue was added; the workmen mixing it with the material as it was being used: but this method often resulted in poor work from neglect to properly mix the parts or add to the batch the proper proportions required. Later, the retarder was added during the process of calcination, about half an hour before the operation was completed, but this method often produced uneven results. At present it is added in a mixing machine as shown in Plate XXXIV, Chapter VI, where exact proportions can be made and thorough mixing guaranteed.

The writer has secured from the Commissioner of Patents, at Washington, numerous copies of patent specifications showing different ingredients used as retarders.

The following are a few of the number received, and will serve to show the great variety of mixtures used:—

Patent No. 433,743 calls for a mixture of glue, glue-stock, or other glutinous or gelatinous substance in water, and added to about eight pounds of this solution, about sixteen pounds of oil, fat, or any other suitable hydrocarbon compound. These ingredients are mixed thoroughly, and the mixture is heated to about 200° Fahrenheit. A suitable hardening acid is slowly added. It is preferred to add about twenty-two pounds of muriatic acid, and about five pounds of sulphuric acid. The mixture is then heated to about 400° Fahrenheit, and stirred, in order to thoroughly commingle the ingredients.

Patent No. 452,346 calls for one part of glue by weight dissolved in thirty three parts of water. This mixture is used for slaking lime, about 4½ gallons of the mixture to every bushel of lime.

Patent No. 301,459 is especially designed for brown or rough coating plaster, and is composed of calcined plaster, sand or powdered cinders, and glue or soap, or sour beer and water.

Patent No. 390,157. In this the following ingredients are called for: one-third of a barrel of plaster of Paris, one-sixth of a barrel of whiting, one-third of a barrel of sand, one-third of a barrel of saw-dust, one-sixth pound of glue, one-sixth pound of Irish moss, one-third quart of molasses, one-third ounce of tartaric acid. The actual retarder consists of the last four ingredients, viz., the glue, Irish moss, molasses, and tartaric acid.

Patent No. 420,008 calls for a mixture of air-slaked lime, plaster of Paris, river sand, and cow hair, with serum or the watery part of the blood of animals with carbolic acid.

Patent No. 456,297 is a mixture of 735 pounds of sand, 470 pounds of plaster of Paris, 140 pounds of slaked lime, 62 pounds of sawdust, one pound of fibre, and one pound of a mixture composed of sugar forty-eight parts, slacked lime forty-eight parts, and bicarbonate of soda two parts.

Patent No. 458,742 consists of a flax seed meal or oil cake meal, after the oil has been extracted, one pound mixed with carbonate of soda or potash one-half pound; lime one-quarter of a pound, boiled in water to a thin mixture, and afterwards adding to it four pounds of any of the salts of the alkaline earths, or salts of the caustic alkalies.

Patent No. 446,604 consists essentially in combining with calcined gypsum a leguminous substance, such as beans, peas, lentils, etc., boiled with a solution of caustic alkali.

Patent No. 393,002 consists of paper-pulp four parts, wool fibre one part, sawdust two parts, lime putty two parts, flour paste one part, the flour paste containing alum in proportion of about two ounces to the gallon of paste. To these is added sufficient water to reduce the mass to a suitable plastic condition to use for plastering in the usual manner. The water so added should contain copperas in solution, in proportion of two ounces to the gallon, and salt one pound to the gallon.

HARDENING GYPSUM BLOCKS.

Considerable experimental work has been carried on during recent years in attempting to harden the soft compact gypsum, and give it the crushing resistance and tensile strength of ordinary marble, without destroying the natural veinings and colour shadings that make it attractive for ornamental and artistic purposes.

Many of these attempts have been successful, and the material is being largely used for inside finish and ornamental work, taking the place of onyx and marble for, mouldings, railings, wainscotting, fronts, pedestals, screens, mantels, and many other uses. It is considered far superior to scagliola, or any of the composite plasters often used for such purposes.

The process of treating the rock to imitate marble is shown in the specifications of United States Patent No. 588,277, which in part says: 'The first step in the process is to dehydrate these articles made out of the native rock by the action of hot air, at a temperature of approximately 330° Fahrenheit for twelve hours, more or less, until the moisture in the native rock is eliminated. A convenient plan is to load the articles formed from the rock on to a truck and run it first into the hot air compartment. After the moisture has been eliminated, the calcium sulphate is porous and ready for cooling. Cooling the rock is the next step in the process. It has been my practice prior to the present invention to cool the hot dehydrated rock by letting it remain for some time in the cool open air; but I find by this plan that the rock is liable to slake more or less, and crack, and what is very objectionable, it becomes impregnated with moisture, which it takes from the open air, thus undoing to a degree the work already accomplished, and retarding and diminishing crystallization in the after treatment. To obviate these difficulties, I allow the rock to cool in a compartment from which the outer air is excluded, and which compartment, while the rock is in it, is charged with the gas or fumes of ammonia. This greatly accelerates the cooling of the hot rock. It does not slake nor crack nor gather to itself the moisture from the outer air, for which reason it may be sooner subjected to the next treatment, and for which reason the next treatment is more effectual.

'While the rock is cooling, a bath composed of a solution of aluminium sulphate is prepared and heated to approximately 100° Fahrenheit. As soon as the rock is cool I immediately immerse it in this warm solution for a short time until the pores are filled.

'The object of warming the solution is to prevent the bursting out of particles of the rock, which has been my experience with the use of a cold bath of this solution; and to improve and accelerate the crystallization, which I find takes place almost immediately in the warm bath. After having been thus treated the rock is allowed to dry and is then polished, presenting a hard surface of beautiful lustre, which cannot be affected by frost or weather, and I have found that even muriatic acid will not affect it.'

In specification of United States Patent No. 549,151, a process for treating gypsum rock to imitate chalcedony is given, which also in part says: 'To this end the crude gypsum rock is first shaped in any desired form and configuration by carving, sawing, planing, etc., and is then freed from the water constituting one of its constituent elements. It is next coloured in accordance with the desired effect, and then it is treated to the action of hardening chemical solutions, all as more particularly set forth below. Beautiful onyx, agate, and other effects can be produced, in accordance with tastes and desires, in statuary, furniture, ornaments and the like, and in the finishing of rooms, using the material in lieu of marble or woodwork. By my treatment the colours are made to appear as if a constituent part or element of the rock in its native condition and formation; and the condition of the product, as stated, is superior in hardness and finish to either marble or chalcedony.

'To carry my process into effect, the gypsum rock from the mines having been given the desired configuration, as stated, is submitted to the drying action of hot air for twelve hours (more or less) until all the moisture has been eliminated. The material is now calcium sulphate, porous from surface to centre, and capable of absorbing sufficient chemical solution to produce the desired effect of the rock and colours.

'To the surface of the dehydrated rock is now applied the mineral colours—such as, for an illustration, solution of copper nitrate and aqua ammonium, or a solution of sulphate of iron, nitric acid, and potassium sulpho-cyanide, or other mineral colours. After colouring, the rock is immersed in a solution of aluminium sulphate ($Al_2 (SO_4)3$) for about fifteen hours, or until the pores of the rock are completely filled. The material is then removed and exposed to the open air for a few hours at a low temperature, and then polished.'

In concluding this chapter it may be said that the demand for the various products of gypsum as above described is ever increasing. This is particularly true in the United States, where the material has attained such prominence in fireproof construction. It has been said that every prominent building in Chicago erected within the last decade has used large quantities; among others, the post office, the Tribune building, the American Trust building, the Marshall-Field Company building, and the Marquette building may be mentioned, the last using over 2,500 tons.

CHAPTER VIII.

Gypsum as a Fertilizer.

The use of ground gypsum, or calcium sulphate, ($CaSO_4$ $2H_2O$), more commonly known to the trade as land plaster, as a fertilizer dates back to very ancient times. Virgil in his writings tells us of its value on cultivated lands. The Germans and French applied it to their lands 200 years ago, and reported satisfactory results. Legend says that in France its beneficial effects were discovered quite accidentally. A workman at one of the plaster kilns had occasion to pass over some pasture lands going to and from his work, and to prevent making a trodden path he travelled a slightly different course each time, over the green sward. It was afterwards noticed that on the parts where he had walked the grasses had a richer colour and a more plentiful crop than on the other parts of the same field. It was assumed that this was due to gypsum being carried on his feet from the kilns and brushed off by the grass.

A great many eminent agricultural writers and chemists, both ancient and modern, have given the subject much serious consideration, and although many of them do not agree in detail, the great majority agree that gypsum has a decidedly beneficial effect on many crops, especially those classed as leguminous, if judicious and intelligently used. The farmer, however, in many cases, has not gi... careful consideration, and often passes the comparatively inexpensive article for the more expensive, which possibly contains the same fertilizing ingredients and will give no better results, if used with similar conditions. This is done somewhat on the principle 'The higher the cost the better the article,' combined with a smooth story from some advertising agent, and a bad smell.

In reviewing the history of the application of land plaster the United States will be taken as an example. Here it will be seen that its use has decreased very materially in recent years, and an attempt will be made to show why this is so.

The United States for many years consumed very large quantities of gypsum as land plaster. Forty years ago the Michigan mills could not supply the demand, while at the same time large quantities of crude rock were being imported from Nova Scotia and New Brunswick, and manufactured for the same purpose. Twenty-five years ago, two-thirds of the quantity produced in that country was ground for fertilizing purposes, but this proportion gradually diminished, until 1890, when the ratio was practically reversed, and there was nearly double the amount of rock calcined, as used for a fertilizer. The proportion of calcined material continued to increase, and in 1907, out of a total production of 1,404,698 tons, only 46,851 tons were used as land plaster.

This, at first glance, would seem like condemnatory evidence against gypsum being used for this purpose, but there are several causes to which the change may be ascribed.

In 1885 the fertilizer law came into force, by which the exact percentage of the different constituents of commercial fertilizers was known. Well organized companies with large capital were formed throughout the whole country for the manufacture of fertilizers, composed of various ingredients. They advertised their product as having all the good qualities of gypsum. This was injurious advertising for the old time gypsum product.

In the use of commercial fertilizers, known as super-phosphates, the ingredient furnished as plant food is phosphoric acid. In manufacturing these, the usual source of supply for phosphoric acid is phosphate rock or animal bones, in which one part of phosphoric acid is combined with three parts of calcium oxide or lime.

This as found in nature is almost always in an insoluble condition; that is, it does not dissolve in water, and to be a benefit to plant life it must be treated in some way to make it soluble. This is usually done by grinding it to a fine powder, and subjecting it to the action of sulphuric acid. The action of sulphuric acid on calcium oxide (lime) forms calcium sulphate (gypsum), and in treating bones or phosphate rock with sulphuric acid, two parts of the calcium in the rock leave its combination with phosphoric acid and combine with the sulphuric acid, forming gypsum. Roberts[1], in referring to the reaction of sulphuric acid on phosphate rock, gives the following note and equation:—

'The phosphoric acid which is used in the manufacture of these superphosphates is obtained from tricalcium phosphate by the action of an excess of sulphuric acid. The reaction may be represented by the equation:—

$$\left.\begin{array}{l}CaO\ldots\ldots\\CaO\ldots\ldots\\CaO\ldots\ldots\end{array}\right\}P_2O_5 + \begin{array}{l}H_2SO_4\\H_2SO_4\\H_2SO_4\end{array} = \left.\begin{array}{l}H_2O\\H_2O\\H_2O\end{array}\right\}P_2O_5 + \begin{array}{l}CaSO_4\\CaSO_4\\CaSO_4\end{array}$$

Here, all the calcium of the tricalcium phosphate unites with the sulphuric acid to form gypsum, and the phosphoric acid, P_2O_5, is united to three parts of water, H_2O.'

By the above it will be seen that the greater part of the superphosphates sold as fertilizers consist principally of gypsum.

Another reason given for the disuse of gypsum as a fertilizer is that the many new uses constantly being discovered for the products of gypsum have caused a rapidly increasing demand for calcined plaster, and the producer finds it more profitable to calcine his whole product. This is substantiated by the fact that, although in recent years, in the United States, much smaller quantities of land plaster are used than formerly, the total production of gypsum and gypsum products has steadily been on the increase.

[1] Roberts Fertility of Land, 7th Edition, p. 110.

The strongest reason advanced, and the one which probably has the most bearing on the question, is the lack of knowledge by the farmers of its exact action when used as a fertilizer.

The experiments made by many authorities show the action to be a very complex one, and that it is twofold. First, it has a chemical action upon the soil in breaking up the double silicates and promoting a distribution of potash and magnesia, and making them available for plant food, which in the absence of gypsum would not be available. This action is clearly and concisely given by Aikman :—

'The true explanation of the action of gypsum is to be found in its action on the double silicates, which it decomposes, the potash being set free. Its action is similar to that of other lime compounds, only more characteristic. As a manure, therefore, its action is indirect, and its true function is to oust the potash from its compounds. Its peculiarly favourable action on clover is due to the fact that clover specially benefits by potash, and that adding gypsum practically amounts to adding potash. Of course it should be borne in mind that the soil must contain potash compounds, if gypsum is to have its full effect. Now, however, that potash salts suitable for manuring purposes are abundant, it may well be doubted whether it is not better to apply potash directly. Further, it must be borne in mind that gypsum is applied to the soil whenever it receives a dressing of superphosphate of lime, as gypsum is one of the products formed by treating insoluble phosphate of lime with sulphuric acid.'[1]

A point here that should be remembered by the farmer is, that gypsum *does not* furnish potash to the soil; it only makes available that which may be in the soil and cannot be released without some chemical action. This is where the farmer is oftentimes deceived. He has used it many times with success, but as time passed it was observed the results were not as good, in fact a failure. He blamed the gypsum as being inferior in quality, when in truth, he had with the application of gypsum taken all the potash, so valuable as plant food, from the soil, and had added nothing to supply it.

Liebig[2], who made many experiments with agricultural soils, shows among others that 1,000 grammes of earth taken from a wheat field, mixed with 3 litres of pure water, dissolved out 24·3 millegrammes of potash, while 3 litres of gypsum water dissolve out 43·6 millegrammes of potash.

To show the action of gypsum water in dissolving out magnesia from the soils he took eight samples of different earths, 200 grammes of each. These he mixed with one litre of pure water, and a like quantity of each he mixed with one litre of gypsum water. The average results showed that while the pure water only dissolved out 24·3 millegrammes, the gypsum water dissolved out 84·5 millegrammes.

Gypsum as a land plaster possesses another and perhaps greater value. It has the property of decomposing the carbonates of ammonia, one of the com

[1] Manures and Manuring, p. 463.
[2] Natural Laws of Husbandry, pp. 326-327.

mon elements of nature, from which the plant receives the nitrogen so indispensable for its nutrition, and fixes it in the soil.

Carbonate of ammonia and sulphate of lime (gypsum) cannot come in contact with each other, at normal temperatures, without mutual decomposition. The ammonia enters into combination with the sulphuric acid, and the carbonated with the lime, forming compounds which are not volatile. This action may be represented thus:—

Carbonate of ammonia....	$(NH_4)_2CO_3$	Sulphate of ammonia	$(NH_4)_2SO_4$
and		and	
		Carbonate of lime ...	$CaCO_3$
		and	
sulphate of lime (gypsum) .	$CaSO_4\ 2H_2O$	Water ...	$2\ H_2O$

The carbonate of ammonia in rain and snow water is decomposed by gypsum in the same manner as in the manufacture of the commercial sulphate of ammonia, so largely used by the agriculturist.

The excrements of animals contain a very large percentage of ammonia in the form of carbonate, very volatile, as it is easily detected by the sense of smell. One of the farmers greatest losses is the loss of the ammonia from this source of supply.

To show this loss the United States Department of Agriculture, Farmer's Bulletin, No. 192, gives the following information:—

'In some recent experiments at the New Jersey stations solid cow dung exposed to ordinary leaching for one hundred and nine days lost 37·6 per cent of its nitrogen, 51·9 per cent of its phosphoric acid, and 47·1 per cent of its potash. Mixed dung and urine lost during the same time 51 per cent of its nitrogen, 51·1 per cent of its phosphoric acid, and 61·1 per cent of its potash. In brief, according to Voorhees, 'more than one-half of the constituents in the total animal manure product of the cow may be lost by an exposure of less than four months.'

'In experiments at the Canada Experimental Farms a four ton lot of horse manure (with litter) kept in an open bin lost one-third of its nitrogen, one-sixth of its phosphoric acid, and a little more than one-third of its potash in one year. A similar lot of manure kept in a closed shed lost one-fifth of its nitrogen, and practically no phosphoric acid and potash.'

Now if the stable floors are covered occasionally with land plaster or if small quantities be mixed with the dung heap, it would be noticed that the offensive smell would disappear, and practically all the ammonia would be saved in a condition serviceable as a manure.

Again, in reference to this loss, Liebig[1] says: 'It should at least be borne in mind that unless means are taken to prevent it the most valuable portion of the manure is constantly escaping, during exposure to air and sun, by evaporation, and also by draining off into the ground, whence instead of a material calculated to afford a ready supply of nitrogen to the plant, we obtain an effete

[1] Reports on Organic Chemistry.

mass, in which that element is in a great measure wanting, and which, therefore, can only influence the growth of plants by virtue of the phosphoric salts and other fixed ingredients still present in it.

'The fact that leguminous plants contain this substance as an essential ingredient may, in some measure, explain its fertilizing effect on them. It is also found serviceable to turnips and cabbages, which do not appear to contain it, nor does it seem easy thus to explain the superior advantages said to result from scattering it in fine powder over the leaves of clover and saintfoin, as is practised in France, and in North America, and with such manifest good effect, that it is said if the substance be partially applied to a field, the portions that have received this dressing may afterwards be distinguished from the rest by the superior luxuriance of the crop.'

Roberts[1] gives a number of experiments on conserving nitrogen by the use of gypsum, from which the following are selected:—

'Experiments in the laboratory were conducted with three samples each of cow and sheep manure, the same amount in each case. To one sample nothing was added, to another sulphate of iron, and to the third gypsum. The six samples, placed in closed vessels, were allowed to ferment from May 27 to October 8, 1883, and the ammonia formed was fixed in standardized sulphuric acid, and determined, with the following results:—

—	Cow manure. Loss of nitrogen.	Sheep manure. Loss of nitrogen.
	grammes.	grammes.
With nothing	0·142	1·512
" sulphate of iron (copperas)	0·085	1·092
" " lime (gypsum)	0·052	0·469

A second experiment was conducted under similar conditions:—

Escaped Ammonia in Grammes.

—	6 Days.	12 Days.	21 Days.	31 Days.	54 Days.
200 c. cm. cow urine, nothing added	0·121	0·333	0·661	0·950	[illegible]
200 c. cm. cow urine, with 2. g. gypsum	0·072	0·165	0·349	0·576	[illegible]

'The experiment shows that gypsum has a conserving effect, but cannot by any means conserve all the ammonia. Air currents were not used in either experiment.

'Experiments in the sheep stable were conducted with sulphate of iron in small quantities. Twenty young sheep were bedded during 21 days on 3 ...

[1] Fertility of Land, 7th Edition, p. 240.

grams (66 pounds) of straw, which from time to time was strewn with sulphate of iron. During the whole of the experiment, 6 kilograms (13·2 pounds) of sulphate of iron were used, or 15 grammes (0·52 ounces) per animal per day. The result showed a loss of 48·5 per cent of the nitrogen taken in with the food. In previous experiments, to determine the proportion of loss of nitrogen [illegible] stable to that contained in the food, the losses were not greater than in this experiment, showing that the sulphate of iron in small quantity had not the [illegible] to reduce this loss.

'The same kind of experiments were conducted with sheep, using gypsum. Twenty young sheep were used for 21 days, on 30 kilograms (66 pounds) of straw, and every 4 or 5 days gypsum was strewn about. The total gypsum used was 12 kilograms (26·4 pounds) or 30 grammes (1·04 ounces) per animal per day. The result showed a loss of 46·1 per cent of the nitrogen taken in with the food. In a second experiment the gypsum was increased. Ten sheep were used for 2[illegible] days on 40 kilograms (88 pounds) of straw. One kilogram (2·2 pounds) of gypsum was used daily, or 100 grams (3·52 ounces) per animal per day. The result showed a loss of 33·9 per cent of the nitrogen taken in with the food. Previous experiments, with no covering material other than straw, showed a loss of 55·3 per cent of the nitrogen in the food. It is seen that the larger quantity of gypsum prevented much ammonia from escaping.'

According to Rees[1] the early farmers of Maryland used gypsum with great success as a fertilizer.

'It was most beneficial on high and sandy soil, and had good effect on wheat, rye, peas, potatoes, cabbage, clover, and all natural grass crops. The invariable result of the several experiments incontestibly proves that there is a most powerful and subtle principle in this tasteless stone, but by what peculiar agency or combination it is capable of forcing vegetation in such an instantaneous and astounding manner is a mystery which time reserves for others to unfold.'

Mr. Charles F. Greece[2], in the Quarterly Review, writing on his observations in the United States and Canada, says:—

'This valuable manure, almost unknown, though very easy to obtain, merits the attention of every farmer. There is scarcely a farm in the provinces but it might be applied to with advantage. The practice of nine years on the following soils and crops may suffice to prove its quality. On a piece of poor yellow loam I tried three grain crops without success; with the last, which followed a hoe crop, I laid it down with barley and the return was little more than the seed. The grass seed took very well. In the month of May of the following year I strewed powder of plaster at the rate of one minot[3] and one peck to the arpent (acre). In July the piece of land being mowed, the quantity of the grass was so great that it was not possible to find room to dry it on the land where it

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[1] Michigan Geological Survey, Vol. IX, Part II, p. 196.
[2] Vol. XXI, pp. 147-150, 1820.
[3] One minot = about 4½ pecks.

grew. The product was five large loads of hay to the arpent. It . . good for five years.'

Ruffin[1], writing in 1832, states:—

'There is no operation of nature heretofore less understood, or of which the cause or agent seems to be so totally disproportionate to the effect as the enormous increase of vegetable growth from a very small quantity of gypsum in circumstances favourable to its action. All other manures, whatever may be the nature of their action, require to be applied in quantities very far exceeding any bulk of crop expected from their use. But one bushel of gypsum spread over an acre of land fit for its action may add more than 20 times its own weight to a single crop of clover hay.'

Harris[2], after making different experiments at the Moreton farm, Rochester, New York, gave the following results in 1878:—

—	Bushel to Acre.	Weight per Bushel.	[illegible]
On field No. 1, without manure	36	22	[illegible]
On field No. 2, with 600 lbs. of gypsum	47	26	[illegible]

There was an increase of 11 bushels to the acre, and nearly one-half . . more straw.

—	Bushels to the A[illegible]
On potatoes with no manure.	[illegible]
" " 100 pounds of plaster to the acre	101
" " 150 pounds of ammonia sulphate	140

He did not find gypsum valuable as a direct fertilizer for wheat, but quotes an old adage that 'clover is good for wheat, plaster is good for clover.'

Messrs. Donald Fraser and Sons, at Plaster Rock, Victoria county, N.B., in 1909, made an experiment with gypsum on the growth of cabbages. A one acre field produced 12,000 heads, having an average weight of 10 pounds each, a total of 6 tons per acre. These were grown in a shallow soil covering the plaster rock.

Aroostook county, in the State of Maine, probably produces a larger quantity of potatoes than any other county in the Union. The practice of the farmers here

[1] Calcareous Manures, p. 151.

[2] Talks on Manures, pp. 126, 254. Michigan Geological Survey, Vol. IX, Part II, p. 197.

is to first roll all their seeds in land plaster before planting, and using on the land at the same time commercial fertilizers in preference to stable manure. In this manner they get the full benefit of the gypsum, without impoverishing the soil.

The Experimental Union of Ontario made a series of experiments extending over a term of five years, and in their report published in 1904, page 25, they give the results as follows:—

'Preparation of seed potatoes. In experiments conducted at the college in cutting potatoes and planting the pieces after they had been sprinkled with lime, plaster, etc., in comparison with planting the pieces without being sprinkled with any material, it was found that those potatoes which were sprinkled with land plaster gave better results than the potatoes prepared in any other way.

'For five years an experiment has been conducted throughout Ontario in order to let farmers ascertain for themselves whether there would be any increased advantage from using land plaster on their seed potatoes before planting. In 1900, 1901, 1902, and 1903, the land plaster showed a marked advantage. In the average of the five years, in which there were in all 97 successfully conducted experiments, we find that the potatoes which were not coated with land plaster produced 177·6 bushels, and those which were coated with land plaster produced 187·7 bushels per acre. In the average results from the five years, therefore, the sprinkling of seed potatoes with land plaster, or gypsum, increased the yield by fully 10 bushels per acre throughout Ontario.'

METHODS OF APPLYING LAND PLASTER.

The amount of land plaster when applied to grass or clover lands varies from 30 to 100 pounds per acre. While some apply as high as 100 pounds per acre, farmers generally agree that from 50 to 60 pounds is sufficient for a hay crop, providing the plaster is evenly distributed. A heavy application produces a growth of too much straw for a seed crop of clover, and from 30 to 40 pounds is generally considered enough by seed growers. This amount applied to young clover is considered very beneficial. It is said that Benjamin Franklin demonstrated this on a clover field near one of the main roads in Pennsylvania by scattering gypsum so as to form a sentence which read, 'This has been plastered with gypsum.' And it is said it could be detected readily by the height and colour of the clover where the gypsum was sown.

With few exceptions land plaster is sown or distributed over the land by hand. It is difficult to sow evenly by hand, too much usually falls in the middle, while not enough reaches the edges of the ridge being sown. In the same way as the sowing is done the crop appears. If distributed evenly the crop appears uniform, if in streaks the crop appears the same.

Again, sowing plaster by hand is very disagreeable work. The sower breathes in quantities, it gets in his eyes, and all over his clothes. Few hired men are willing to undertake the work, and the farmer generally has to do it himself. He, endeavouring to make an even distribution, usually uses more than necessary for his crop.

Within recent years, however, several attempts have been made [illegible] United States to construct some inexpensive machine to do the work an[d] results are submitted to the United States Department of Agriculture b[y] Byron Hunter, in circular No. 22.

What seems the most satisfactory is that known as Olson's Land P[laster] Distributor, reproduced here with the description taken from the abo[ve-men]tioned circular. Figures 16 and 17 illustrate this distributor. "It consi[sts of a] long box or hopper, mounted on an old pair of mower wheels. A larg[e] shaft revolves in the bottom of the box to agitate the plaster. The imp[lement h]as a tongue and is drawn by two horses. The box is shaped very mu[ch like] the box of an ordinary grain drill. It is 11 feet long, but can be mad[e any] length desired. The bottom of the box is 1⅞" thi[ck], 7½" wide, and 11 [feet] long, thus projecting far enough beyond the ends of the box to furnish s[upport] for the bearings. The front and back pieces of the box are 1⅛" thick [and] wide. The lower edges of the side pieces rest on top of the bottom piece. [The] ends of the box are 1⅛" thick. Each end consists of two pieces. The l[ower] piece is about 4" wide, and has a half circle cut in the middle of its upper [edge]. The upper piece has a half circle cut in the middle of its lower edge. When [the] two pieces are put together they form a circular hole, through which the sh[aft] passes. The end pieces fit the shaft snugly, so that the plaster will not w[ork] out. The ends fit in grooves cut in the side pieces. They are held in plac[e by] small rods that run across the box. To protect the plaster during showers [the] box is provided with a lid 13" wide.

"Holes for the plaster to pass through are cut in the bottom [of] the box. See Fig. 17, detailed figures 1 and 2. These are ⅜", 2¼" l[ong] and 3" apart. These holes run across the box—that is, the length of the hol[es is] at right angles to the length of the box. On the under side, the holes [are] about an inch wide. A piece of galvanized iron, with holes corresponding [to] these just described, is placed in the bottom of the box in such a way as to [form] a curved bottom. See Fig. 16, detailed figure 4, which shows a cross-sect[ion of] the box. This piece of galvanized iron is 8" wide, and is as long as the [inside] of the box. Its edges are nailed to the sides. Another piece of galvanized [iron] 10" wide, with corresponding feed holes, fits snugly over the stationary [piece] fastened to the bottom of the box. This upper piece of iron is movable len[gth]wise of the box. Its edges pass up the sides of the box and are covered by cle[ats]. The cleats are narrow strips of galvanized iron 1½" wide nailed to the sides [of] the box. They are bent in the middle to give room for the edges of the shee[t of] galvanized iron they cover. It will be seen that the upper piece of galvan[ized] iron is held in place by the cleats only, and can be moved lengthwise in eith[er] direction to open or close the feed holes.

"The wheels of the implement are old mower wheels. A large iron sha[ft] runs through the bottom of the box and connects the two wheels. At the end [...]

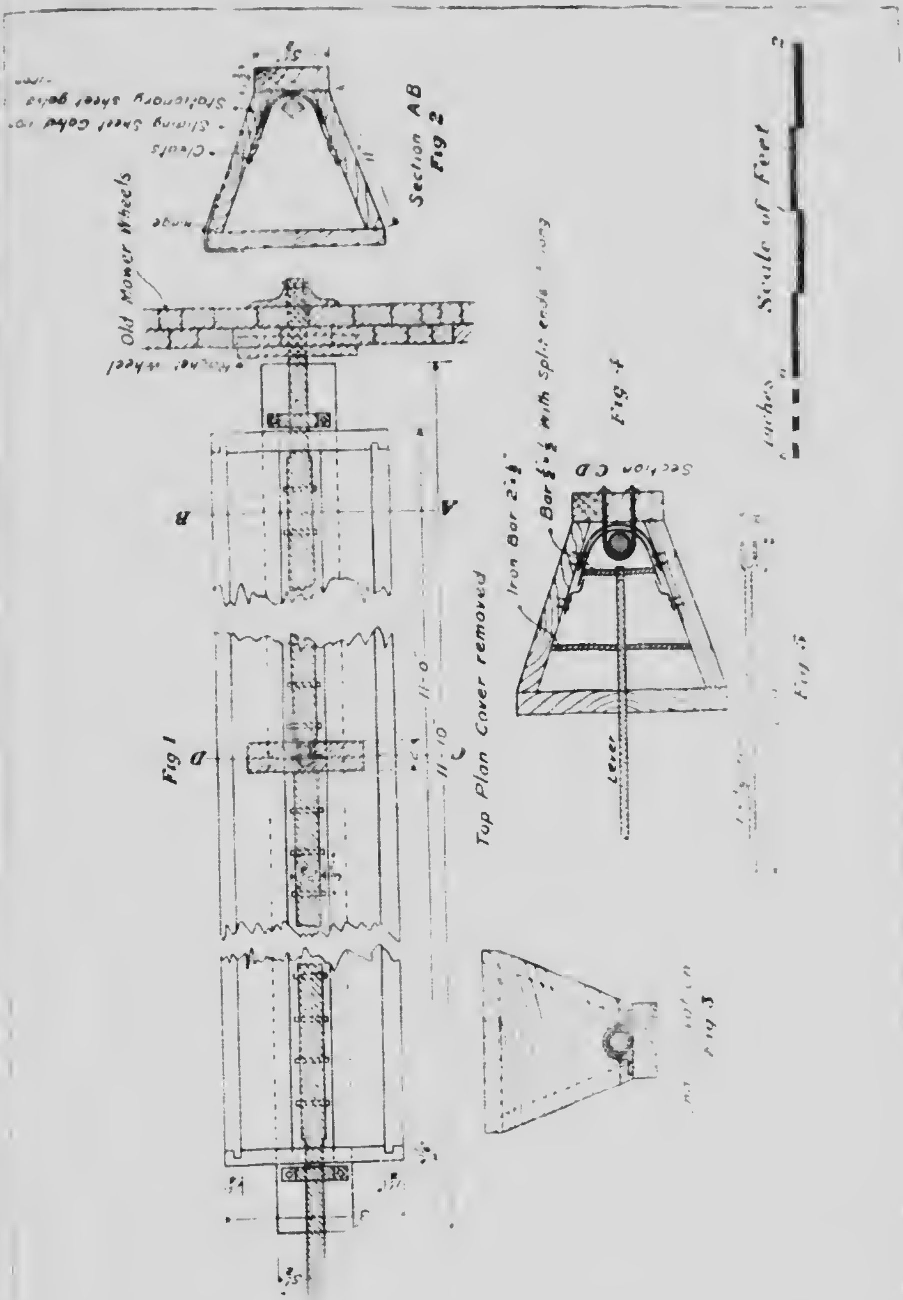
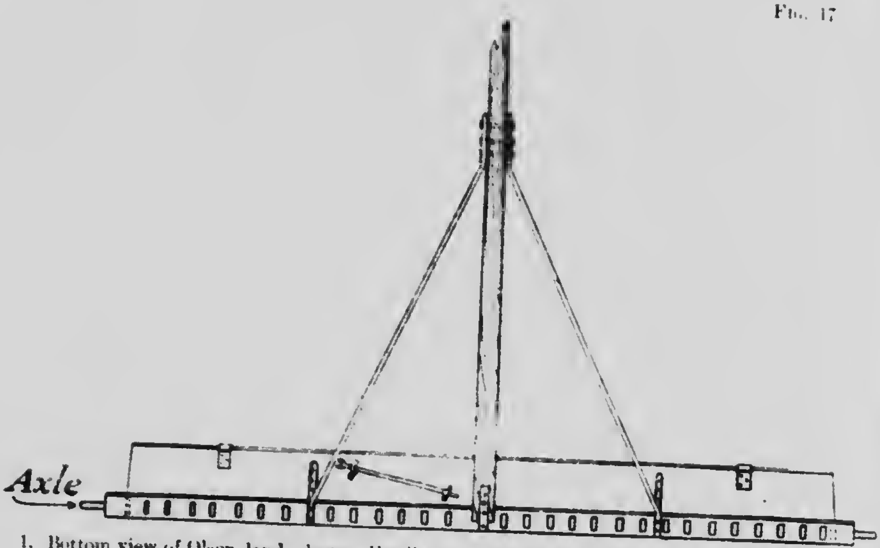
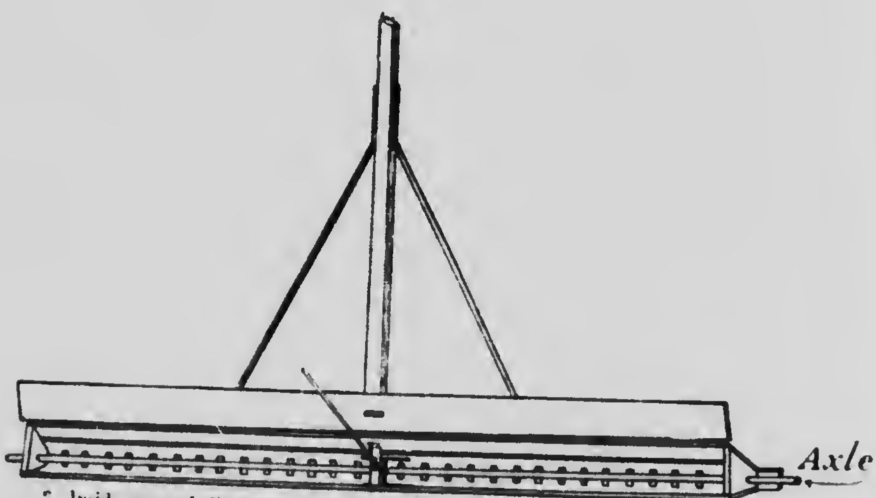

Section AB
Fig 2
Cleats
Old Mower Wheels
Fig 1
Top Plan Cover removed
11-0
Iron Bar
Fig 4
Section CD
Lever
Fig 5
Fig 3
Scale of Feet
Inches

Fig. 17



1. Bottom view of Olson land plaster distributor, showing the holes in the box through which the plaster passes, the attachment of the tongue and its braces to the box and the lever for adjusting the feed carried in straps on the front of the box.



2. Inside view of distributor, showing the feed holes, the square rod that revolves in the bottom of the box, and the position of the lever when used in slipping the upper sheet of galvanized iron to open or close the feed holes.

this shaft is cylindrical, but on the inside it is 1¼" square. The turning of this square rod in the bottom of the box constantly works the plaster out through the feed holes and keeps it from packing in the bottom of the box. In fact the turning of this square shaft in the bottom of the box is one of the essential features of the implement. It must be perfectly square and be so located that the corners will just touch the galvanized iron when it turns.

'Another point essential to observe in the construction of this implement is making the holes in the two pieces of galvanized iron. They must exactly correspond. If they do not, some of the feed holes will be larger than others and the plaster will be distributed unevenly.

'After the holes have been cut, the two pieces of galvanized iron are riveted together, put into a vise, and the margins of the holes are filed until they exactly correspond, after which they are taken apart and placed in the feed box, as already indicated.

'In the middle of the box, just over the large shaft that revolves, a bar of iron half an inch square passes across the box. The ends of this bar are split, flattened out, and riveted to the top sheet of galvanized iron just below the cleats already described. The split ends of the bar are 7" or 8" long, to give the union strength. Just over the square ½" bar of iron a flat bar of iron 2" wide, with a hole in its centre, is bolted across the top of the box. By running a lever down through this hole and prying on the ½" bar of iron the upper sheet of galvanized iron may be slid either way, thus opening or closing the feed holes. The lever used for this purpose is a flat piece of iron 2 feet long, ⅜" thick and 1" wide. In the lower end of the lever is a ½" notch that permits the lever to slip over the ½" bar of iron. See Fig. 16, detailed figures 4 and 5.

'As previously stated, the bottom of the box projects beyond the ends. Upon these projections the bearings for the shaft are bolted. The shaft is round until it passes through the end of the box, for about 2" at the middle point; elsewhere it is square and revolves in the bottom of the box. There is a bearing in the centre of the box where the shaft is made cylindrical, a broad staple being driven down over the shaft. This staple passes through the bottom, and an iron plate that is fastened underneath the tongue. It is fastened below with nuts. This centre bearing is necessary to take the shake out of the shaft and hold it in place so that it will rub the bottom just right.

'In addition to being bolted to the bottom the tongue has iron braces on either side. To keep the box from spreading there are two iron stirrups that fit on the under side of the box. The stirrups and side braces of the tongue are bolted to the bottom of the box. See Fig. 17, detailed figure 1

'The wheels of all these implements that have been made have been taken from old mowers. The wheels best suited for the purpose are those provided with ratchet wheels into which pawls or catches drop and cause the shaft to revolve when the implement is moving forward. Only one ratchet wheel is necessary if the implement is driven around the field to be plastered, with the ratchet wheel on the outside. Some means should be provided for raising the catches that drop into the ratchet wheel so that the shaft will not revolve when going to and from the field. Otherwise it will be necessary to close the feed holes. If wheels with ratchets are not to be had a hole may be drilled through the shaft and the hub of one of the wheels. The shaft will be revolved by putting a pin through this hole. The implement should then be driven around the field with this wheel on the outside, so that the plaster will be sown when turning the corners. When taking the implement from one place to another the pin in the end of the hub can be removed. With the pin out the shaft will not turn, and little or no plaster will be sown.

'The construction of this distributor costs from $35 to $40. The help of a smith is necessary. This is a very efficient implement, and so far as the writer knows, fails to work only when the plaster is very damp. When the plaster is in this condition it sticks to the feed rod and does not go through evenly. Under these conditions it is necessary to spread the plaster in the sun to dry. With this machine it is not necessary to screen lumpy plaster. The lumps are pulverized by the feed rod.'

CHAPTER IX.

Manufacturing and Estimates of Costs, with Miscellaneous Notes.

Manufacturing gypsum into its various products, in Nova Scotia and New Brunswick, is carried on at three different points. The oldest mill is that of the Albert Manufacturing Company, which has been operating as a chartered company since 1854.

Here in the early history of the Company a plaster mill was erected, under very favourable conditions for a prosperous trade with the United States, but later the withdrawal of the reciprocal trade relations between the two countries seriously interfered with its operations.

The Canadian market at this time, owing to the existing transportation facilities, was not available for Hillsborough. The Intercolonial railway was not built, and although there was considerable demand for the manufactured product in the Upper Provinces, it was supplied either from the crude rock being shipped from eastern Nova Scotia and manufactured in Montreal, or from the Michigan mills, which, owing to the very low rate of duty, could ship their product to Canada at prices which prevented competition.

However, with an increase in the duty and the superiority of Hillsborough rock, together with rail connexion, the prospects looked much brighter, and the trade gradually increased until 1897, when Hillsborough supplied 38,000 barrels to the Canadian market.

At the same time, this Company had under the Wilson (U.S.A.) tariff secured considerable trade in the United States, averaging in the eighties about 20,000 barrels annually, but under the Dingley bill, by which the United States imposed a duty of $2.25 per ton on the manufactured article, and 50 cents per ton on crude rock, it was with the greatest difficulty that the trade secured could be maintained, in fact it would not have been, had not the Albert Manufacturing Company been able to place a superior article on the market.

The Albert Manufacturing Company's mill at Hillsborough is a four kettle mill of modern type, with cooperage and storage facilities complete. It is shown in Plate XXXV. A detailed description would only be a repetition of a similar mill given in Chapter V, and serve no purpose. The products manufactured are hard wall plaster, plaster of Paris, and terra alba.

At Windsor, Nova Scotia, the Windsor Plaster Company has a three kettle mill, in which they manufacture a wall plaster known as selenite cement, and plaster of Paris, for the home market.

The latest installation of plaster mills is a one kettle, electrically driven mill, of the Great Northern Mining Company, Limited, at Cheticamp, C.B.

Nova Scotia. Fig. 18 shows the ground plan and general layout of machinery. Fig. 19 shows a longitudinal elevation of the same, and the following is a specification of the machinery installed:—

Power—Two 72″ × 18 ft. boilers, 150 horse-power each.

One 19″ Robb engine, 210 horse-power, with heater, separator, and duplicate water systems.

One 125 k.w. generator with exciter.

One 50 horse-power electric motor for driving rock breaker, pot crusher, elevator to dryer, dryer, and dryer fan.

One 40 horse-power electric motor for driving No. 1 burr mills, conveyer, and elevator to ground bins.

One 40 horse-power electric motor, for driving conveyer from hot pit, elevator to calcined bin, No. 2 burr mills, conveyer and elevator to finished bin, mixer, hair picker, barrel packer, and bolter.

One 30 horse-power electric motor, for driving kettle agitators.

One 5 horse-power electric motor, for driving elevator to dried uncalcined bin.

Other machinery—one rock screen or grizzly, over which rock passes to the crusher.

One large crusher or preliminary breaker. (Mogul.)

One pot crusher for fine crushing.

One open belt elevator, provided with 14″ six ply rubber belt, 12 × 7 malleable iron buckets, double belt pulleys, shafts, boxes, and takeups complete. This elevator conveys stock from crusher and delivers it to stock bin over dryer.

One No. 1 Triumph automatic feeder for feeding stock from stock bin to dryer.

One Triumph direct heat rotary cylinder dryer complete, including stack and all furnace fixtures.

One screw conveyer to take stock from tail end of dryer and deliver same to elevator.

One steel cased elevator, 28 ft. centres. Case made of No. 14 steel 12″ × 48″ inside; all joints joined with 2″ × 2″ × ¼″ angles, and riveted dust tight. This elevator is equipped with all necessary shafting, boxes, sprockets, takeups, using No. 086 chain, and 8″ × 5″ heavy malleable iron buckets.

Two 36″ under running gear driven, French burr mills, complete with feeders.

One screw conveyer to take stock from two 36″ mills and deliver same to elevator.

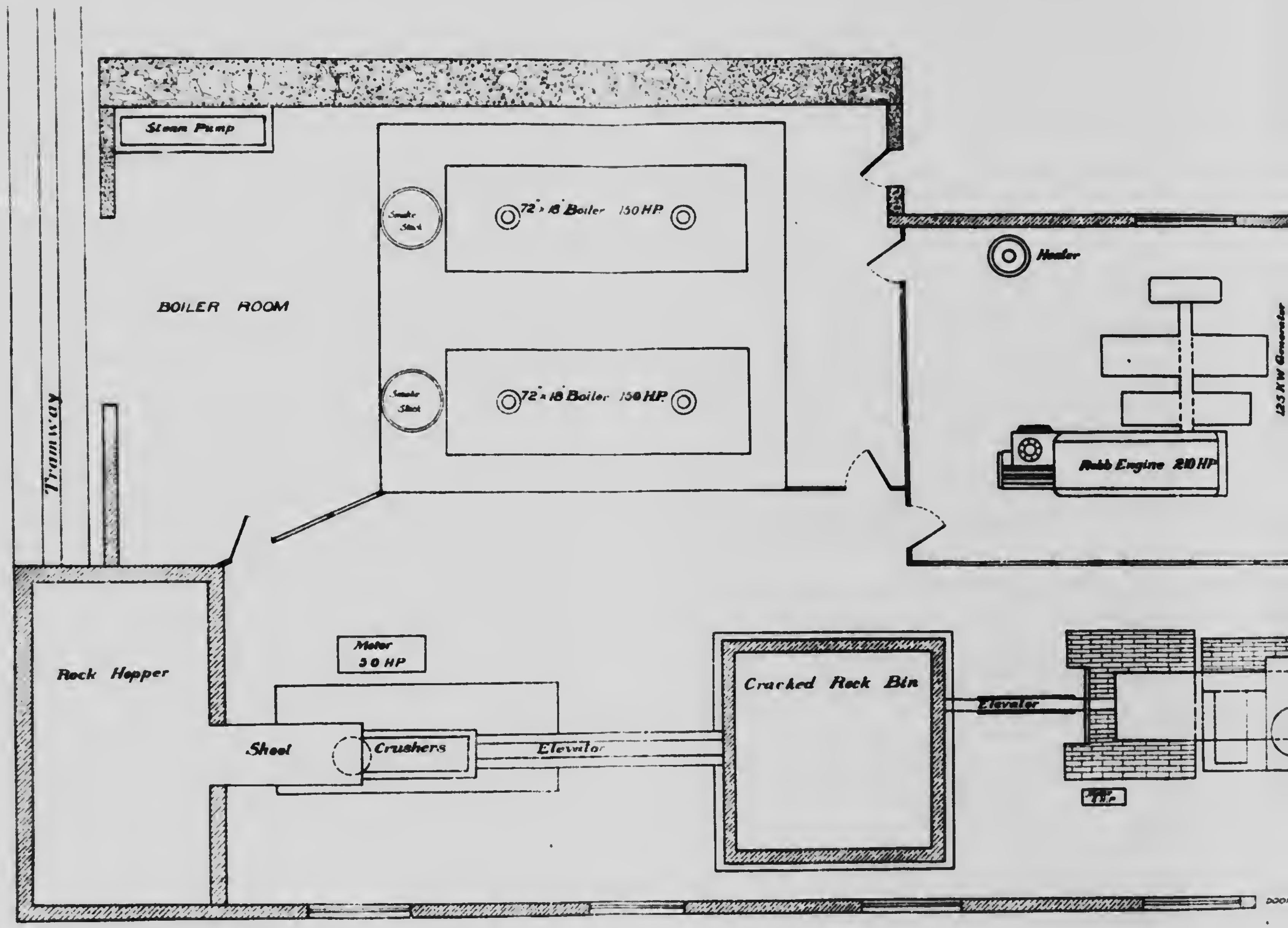
One No. 14 steel cased elevator, 48 ft. centres, case 12″ × 48″ with fittings, a duplicate of foregoing elevator.

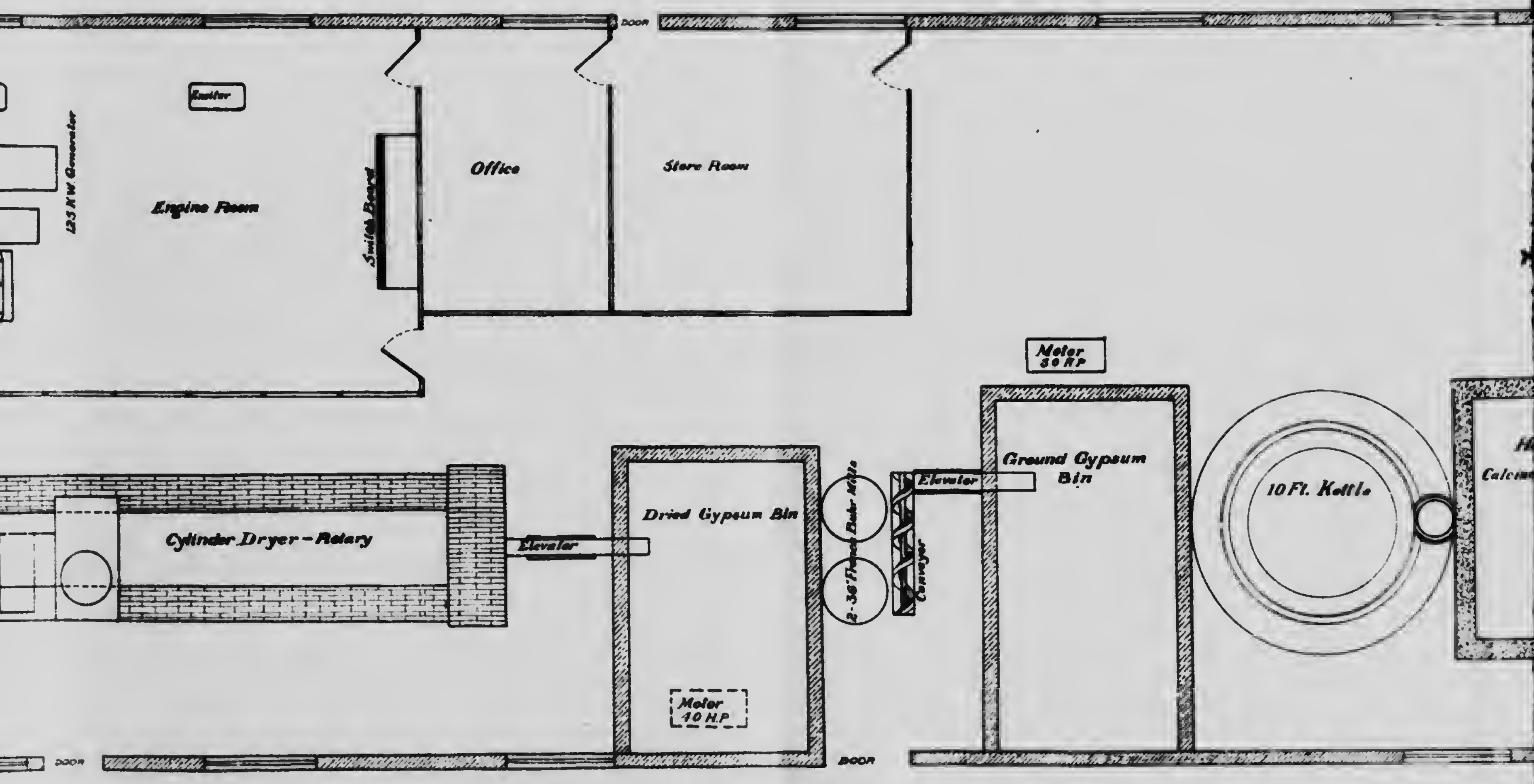
One 10 ft. × 10 ft. kettle fitted complete, with all iron work, including stack bevel gears, driving pulleys, and furnace irons.

One 12″ screw conveyer 12 feet long, to take stock from bin below the kettle and deliver same to elevator.

PLATE XXXV.

Albert Manufacturing Company's mill, Hillsborough, N.B.

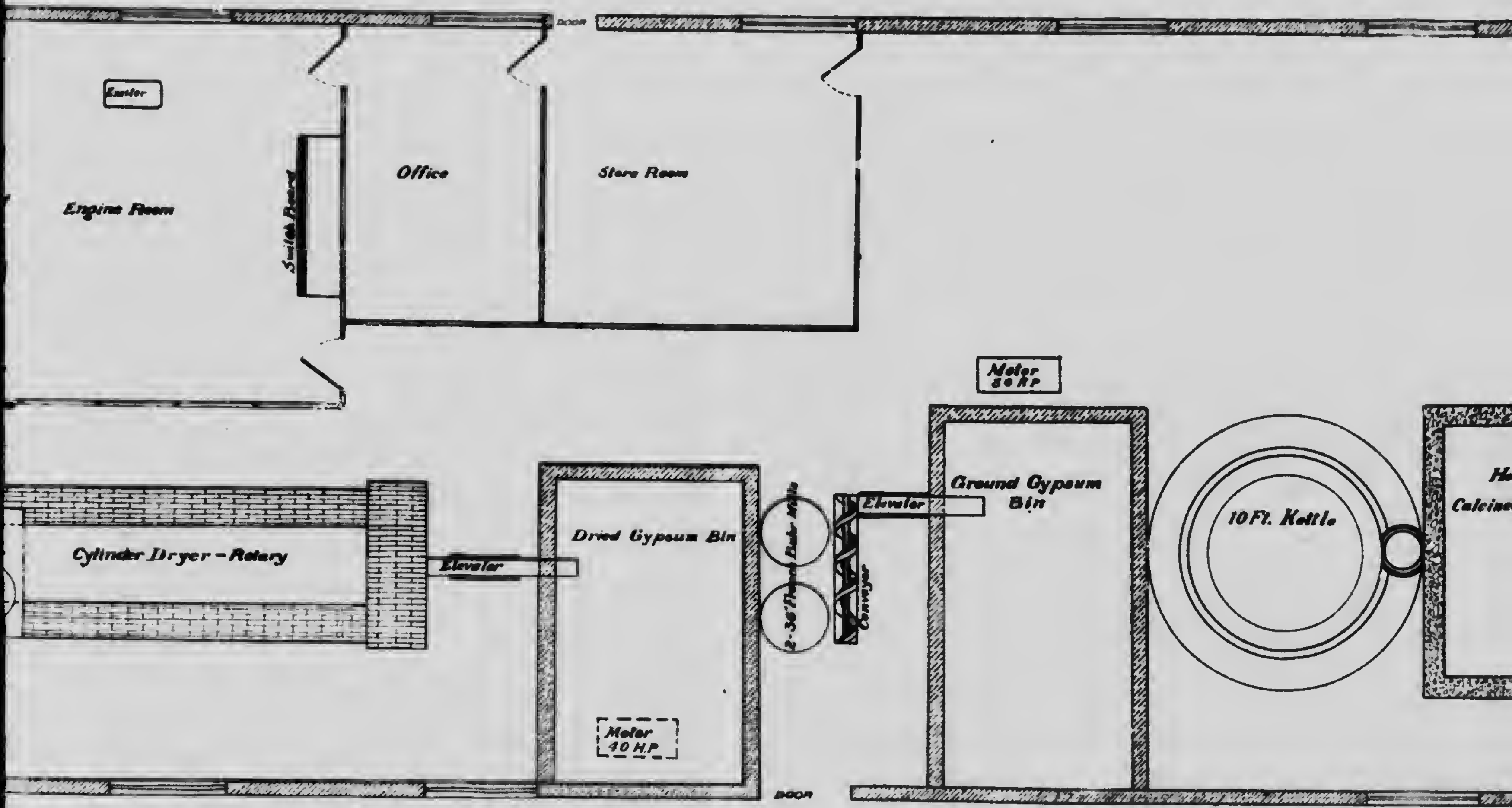

Steam Pump
72" x 18' Boiler 150 HP
Smoke Stack
BOILER ROOM
72" x 18' Boiler 150 HP.
Smoke Stack
Tramway
Heater
125 KW Generator
Robb Engine 210 HP
Motor
30 HP
Rock Hopper
Cracked Rock Bin
Elevator
Shoot
Crushers
Elevator



GENERAL LAYOUT OF GYPSUM MILL

GREAT NORTHERN MINING CO. LTD.

EASTERN HARBOR,
INVERNESS CO. NOVA SCOTIA.

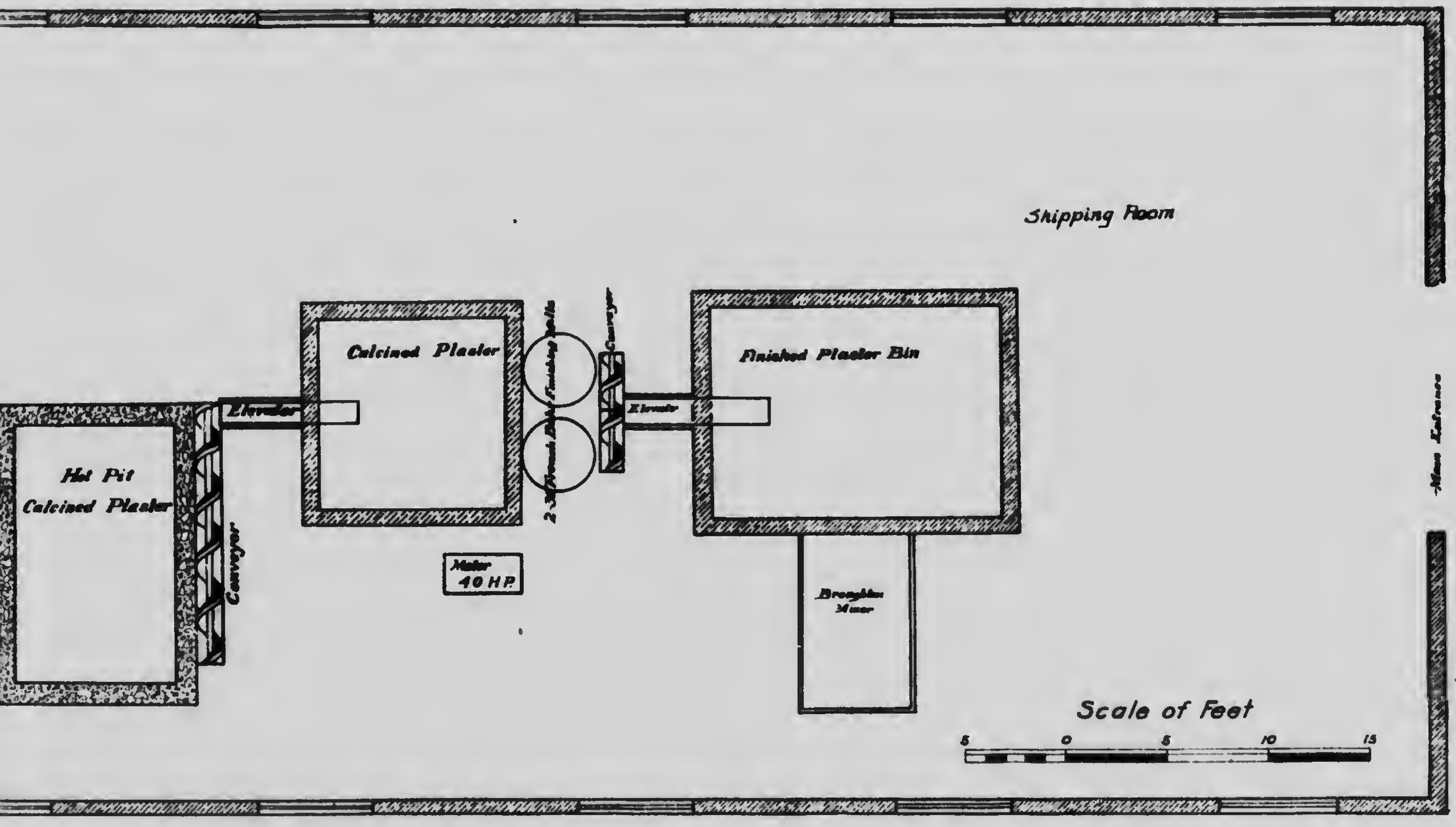


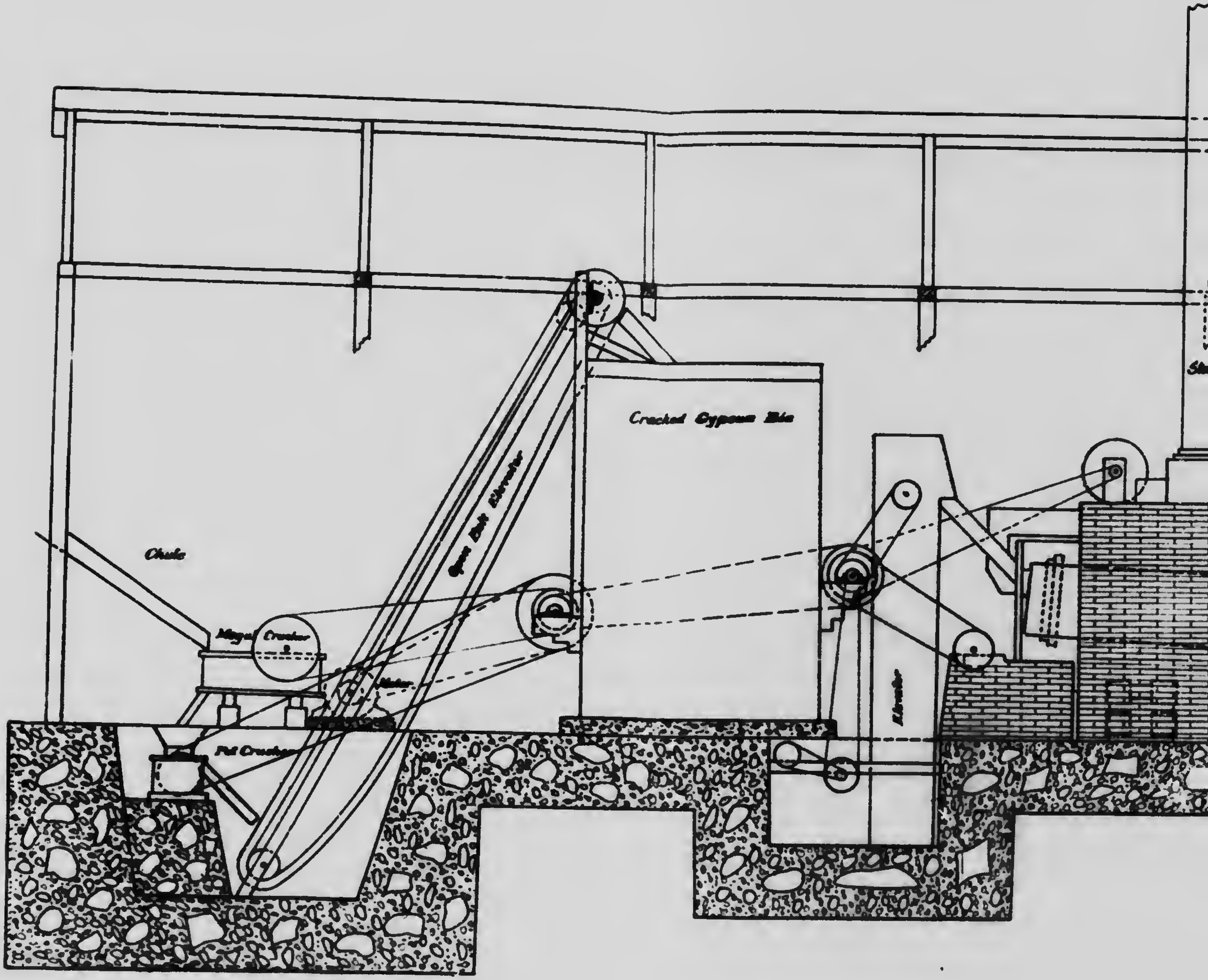
GENERAL LAYOUT OF GYPSUM MILL

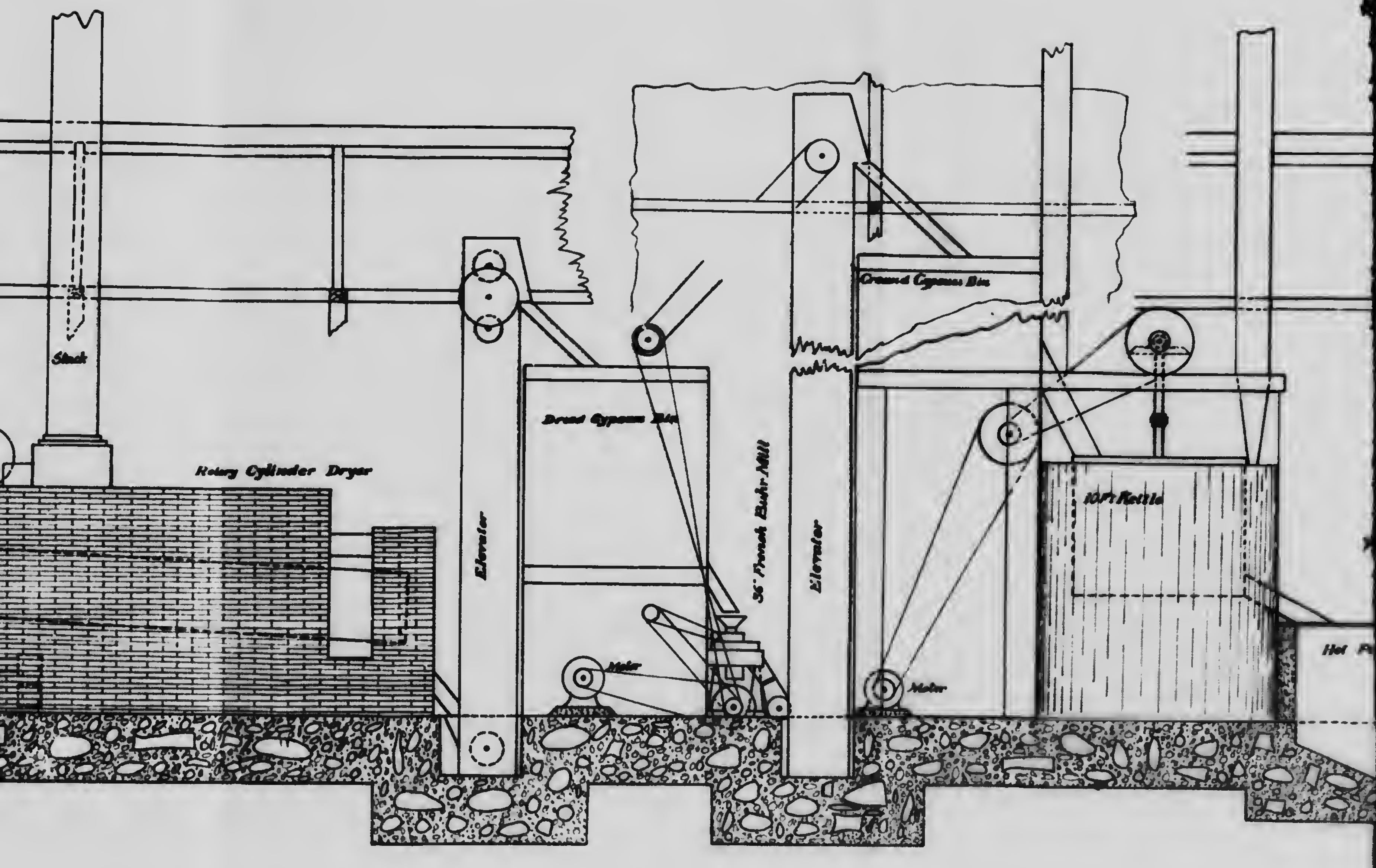
GREAT NORTHERN MINING CO. LTD.

EASTERN HARBOR,
INVERNESS CO. NOVA SCOTIA.

FIG.18


Shipping Room
Calcined Plaster
Finished Plaster Bin
Hot Pit
Calcined Plaster
Elevator
Elevator
Conveyor
Conveyor
Motor
40 H.P.
Main Entrance
Scale of Feet
5
0
5
10
15

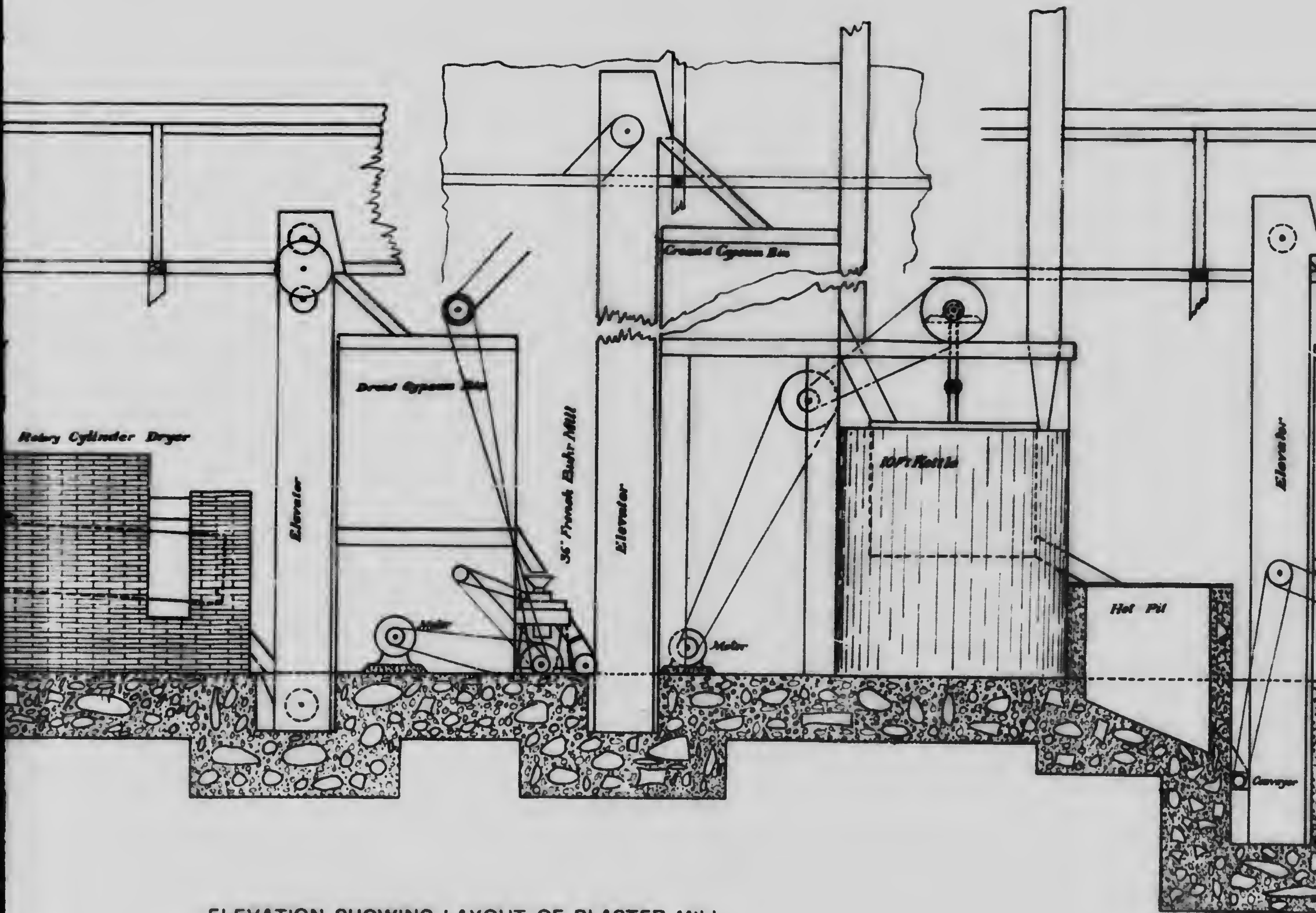

Cracked Gypsum Bin
Open Belt Elevator
Chute
Crusher
Pit Crusher
Elevator



ELEVATION SHOWING LAYOUT OF PLASTER MILL

GREAT NORTHERN MINING CO. LTD.

INVERNESS CO. NOVA SCOTIA

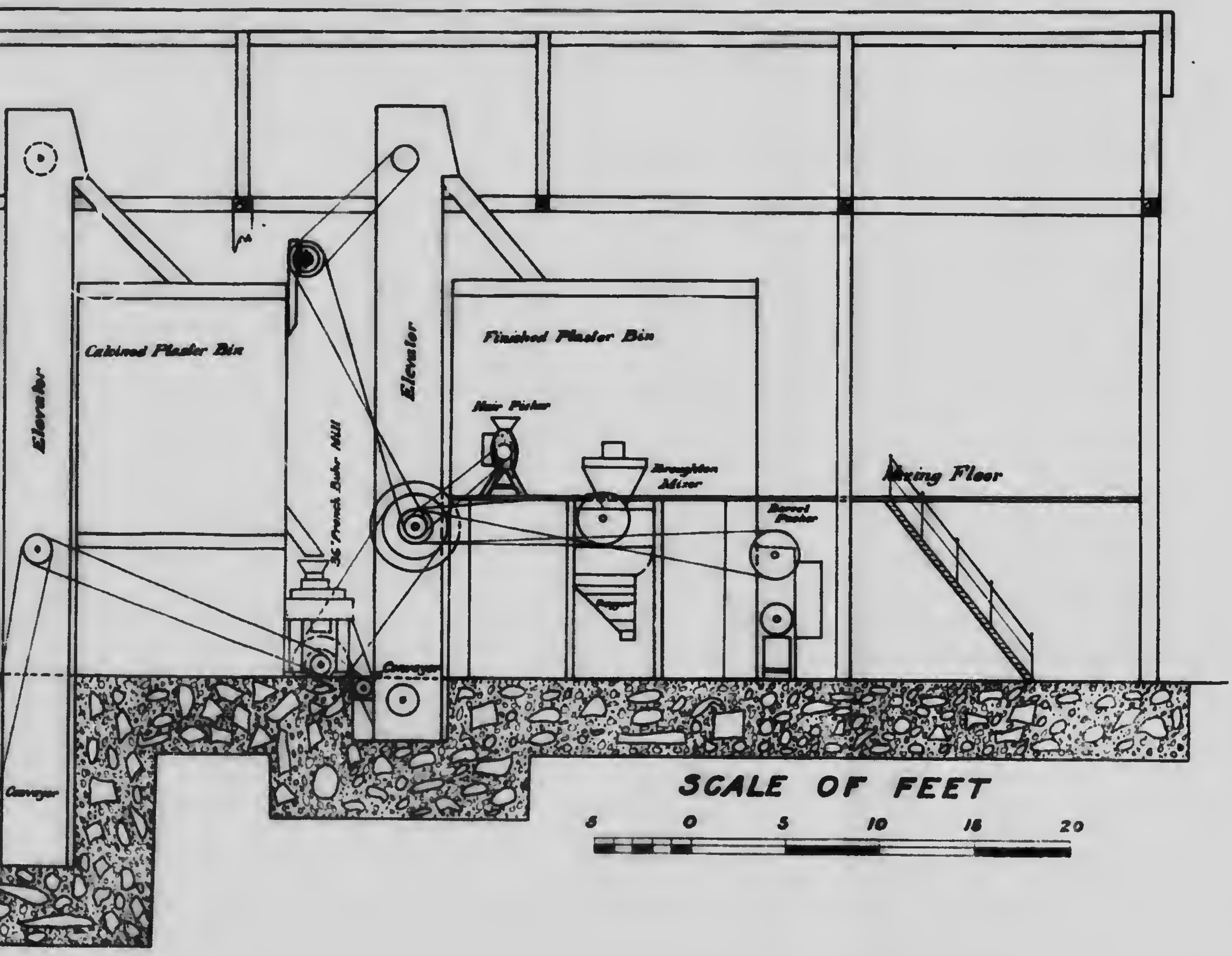


ELEVATION SHOWING LAYOUT OF PLASTER MILL.

GREAT NORTHERN MINING CO. LTD.

INVERNESS CO. NOVA SCOTIA

FIG 19



Elevator
Calcined Plaster Bin
36" French Buhr Mill
Elevator
Finished Plaster Bin
Hair Picker
Broughton Mixer
Mixing Floor
Barrel Packer
Conveyor
Conveyor
SCALE OF FEET
5 0 5 10 15 20

One No. 14 steel cased [illegible] tings a duplicate of the [illegible]

Two 36" under running [illegible]

One screw conveyer to take [illegible] elevator.

One steel cased elevator, [illegible] the same fittings as the previ[illegible]

One Broughton mixer.

One hair picker.

One packer to pack material [illegible]

One barrel packer.

This Company furnishes [illegible] gypsum products manufactured [illegible]

'Our electrically equipped [illegible] tons per day.

'We manufacture wall [illegible] gical and statuary plasters, [illegible]

'*Alba OX*, wall cement, [illegible] tain materials to retard the set [illegible] of hair.

'*Alba X*, wall cement, a pl[illegible] hair.

'*Alba XX*, stucco, a plaster of Pa[illegible] of pure gypsum. It is not as finely gr[illegible] XXX [illegible] minutes.

'*Alba XXX*, white finish or plaster of Paris, a snow-white pure calcined plaster, 90 per cent of which will pass through a 100 mesh screen. It sets in from 5 to 10 minutes.

'*Alba XXXX*, surgical and statuary plasters, similar to XXX but finer ground. These plasters set in about 5 minutes.

'*Alba XXXXX*, dental plasters specially prepared for the dental profession. A very pure snow-white plaster, setting within 5 minutes.

'*Alba*, land plaster, this is a specially prepared ground uncalcined plaster. Valuable around houses and stables. It absorbs the ammonia in such places and fixes it, making it a very valuable fertilizer.

'*Terra Alba*, a very finely ground and pure uncalcined plaster, used as a diluent for medical preparations, etc. OX and X are cement plasters, and contain sufficient retarder to hold back the set for two hours, in order that the workmen may have time to spread the plaster on the wall and properly trowel it down. From 1½ to 2 parts of good screened sand may be used to one part of OX or X. For the convenience of the trade the proper amount of hair is mixed in OX. If desired we can adjust the setting time of OX, X and XX from one to twenty-four hours.

'All the above brands are put up in sacks holding 100 pounds. An extra charge of 10 cents is made for each sack, which is rebated on return of sack.

The following are the results of analyses made by Milton Hersey Compan from samples of the manufactured product of the Great Northern Mining Co pany:—

—	OX	XX	XXX	XXXX	XXXX
Lame	39·19	38·87	39·45	39·29	39·3[illegible]
Magnesia	tr	tr	tr	tr	0·0[illegible]
Ferric oxide and alumina	0·04	tr	0·16	0·06	0·0[illegible]
Sulphuric anhydride	54·80	55·19	53·96	54·95	54·3[illegible]
Carbonic anhydride	0·96	0·91	1·07	0·61	
Water, loss on ignitiou	4·45	4·40	4·90	4·65	4·7[illegible]
Insoluble mineral matter	0·18	0·36	0·16	0·16	0·1[illegible]
	99·62	99·73	99·70	99·72	99·6[illegible]

Costs.

The cost of crude rock varies very much with the condition of its occur rence in different quarries.

If a quarry is free from an overburden of clay and anhydrite, and has suf cient height of face to make a good working bench, the cost of production ma be very low, when the opposite conditions make excessive costs. By the oper tors it is considered unprofitable to operate when the clay overburden in heig exceeds the height of rock face; even where they are equal, it is necessary have a quarry of superior rock, and free from anhydrite, to work with any pr when the price is less than $1 per ton, f.o.b. wagons.

Under favourable conditions the rock can be prepared for shipment at following prices:—

Blasting	$0 10	per ton 2,240 pounds.	
Breaking and loading wagons	0 08	"	"
Removing waste from quarry	0 06	"	"
	$0 24	"	"

In a few of the quarries of Nova Seotia this price is excessive, whil many others it is much too low. Where the business of shipping the cru rock, and manufacturing, is carried on at the same place, the rock, under fav able conditions, should not cost as much as where the two operations are carr on separately.

The reason is this, where shipping the crude rock is the only operation waste is much greater. The spalls made in blasting and in breaking the plas sufficiently small to handle (one man size) are very considerable, and in quarries go to the waste dump. If manufacturing were carried on, these spa would be a clear gain and worth more to the mill than the coarser rock, would require less crushing. It is, therefore safe to estimate that when a is located at or near the quarry the cost of rock will not exceed 24 cent ton of 2,240 pounds.

The loss of weight in manufacturing is also a matter of consideration. Where the hygroscopic water does not have to be considered, the usual allowance made for the loss is from 20 to 25 per cent, according to how near complete dehydration the manufactured product requires to be, together with the waste of material, which is often appreciable. We may therefore estimate that to produce one ton (2,000 pounds) of calcined plaster it will be necessary to furnish 2,500 pounds of crude rock, which will cost, as above estimated, about 27 cents. Assuming coal to be used as fuel, and its cost at mill $3 per ton of 2,240 pounds, the following calculation can be made:—

2,500 pounds crude rock in mill	$ 0 27
250 " coal for power, and calcining kettle	0 34
Labour at mill	0 35
Cost per ton of 2,000 pounds	$ 0 96

To this must be added the cost of package, which, if put up in jute bags, will be:—

20 bags at 8c. each	$ 1 60
Total cost of 2,000 pounds calcined plaster	$ 2 56

This cost is exclusive of all fixed charges, as office, depreciation, and interest charges.

If a cooperage is operated in connexion with the plaster mill, under favourable conditions plaster barrels can be made for from 25 to 27 cents each, and although it is somewhat more expensive to use barrels, a better guarantee of quality can be assured, especially when the stock has to be warehoused for any length of time.

Referring to calcination by the rotary process, Eckel[1] gives the following:

'The rotary process of plaster calcination has not been used at enough plants to give accurate limiting figures of costs, but the following estimates are believed to be fairly close':—

—	Maximum	Minimum
	$ cts.	$ cts.
Mining or quarrying 2,400 lbs. gypsum	0 72	0 12
Power fuel at mill, 50 to 80 lbs. coal	0 1[illegible]	0 04
Kiln fuel at mill, 150 to 200 lbs. coal	0 31	0 10
Labour at mill	0 50	0 18
Total	1 4[illegible]	0 44

Freight Rates

As has been noted in a previous chapter, the market in the past for Nova Scotia and New Brunswick gypsum has been in the United States. The rock

[1] Cements, Limes, and Plasters.

during late years has been sold f.o.b. ship at port of shipment. The price varied, generally according to quality of the rock, from 75 cents to $2.25 per ton, the average price being about $1.25 per ton of 2,240 pounds.

The freight rate from Minas Basin ports to New York and ports south, by schooner, is about $1.60 per ton, while nearer ports are proportionately [illegible]. Canadian vessels are not allowed to do coastwise freighting on the United States coast, and, therefore, cannot compete with American vessels in this southern trade, as they often get a return freight to northern ports. Very little of this trade, however, is done with sail vessels. The greater part of the gypsum from the Minas Basin ports is taken by Messrs. J. B. King and Company, in their own barges, about one-half of which are American bottoms and can be utilized during the winter season, when the Bay of Fundy is closed to navigation, in the southern (U.S.A.) trade; while the Canadian bottoms are hauled up and [illegible] only as storehouses.

In this trade, exclusive of Messrs. J. B. King and Company, th[illegible] Nova Scotia and New Brunswick, the time chartered steamer is fast r[illegible] the sailing vessel, and where quick despatch can be given the freight rate [illegible] very much reduced.

The following data is given as a reliable basis for calculation on [illegible] chartered steamers:—

Taking New York as the port of destination, and a steamer of 2,500 [illegible] capacity, such a steamer would carry, if bunkered in New York for the round trip, from 2,350 to 2,400 tons; if bunkered at loading port about 100 or 150 tons less. If built on modern lines it should not draw over 17 feet of water when loaded, and should have an average speed of 200 nautical miles and burn about 15 tons of coal per day. The cost of such a steamer (rates quoted for 1910) would be from £500 to £550 per calendar month. Using a 30 day month as a basis of calculation, the cost would be from $81.11 to $89.22 per day.

The port charges in New York would be in the vicinity of $300 per trip, exclusive of discharging costs, and at port of loading should not exceed $75 per trip.

The first three trips these charges will be somewhat increased on account of having to pay the 'sick mariner's' fund (1½c. per net register ton) and for the first two trips a fee of $5 each trip is chargeable for harbourmasters dues.

As an example, take a Minas Basin port for receiving cargo and the port of New York as discharging, approximate distance, 594 miles or for round trip 1,188 miles:—

Time allowed for loading	....	2 days.
" discharging	....	3 "
" sailing	....	6 "
Total time required for a round trip	....	11 days.

Allowing the consumption of bunker coal to be equivalent to eight days steaming, and that the steamer bunkers in New York for the round trip, we then have:—

120 tons coal at $3.50 per ton	[illegible]
Port charges in New York....	[illegible]
" Nova Scotia	[illegible]
Cost of steamer, 11 days at $85 [illegible] per day	[illegible]
Total cost of round trip, exclusive of [illegible] master dues, and pilot fees, which vary [illegible]	[illegible]

This is equivalent to a rate [illegible] per [illegible] 2,375 tons; a material reduction in [illegible] should be if the business had sufficient magnitude [illegible] modern loading appliance.

United States [illegible]

For some years there has been a [illegible] States between the producers of the [illegible] sum on the Atlantic sea-board, whose [illegible] on this subject before the Committee on Ways and Means in Washington [illegible] in November, 1908, brought out [illegible] following are gleaned.

The manufacturers using exclusively [illegible] Nova Scotia and New Brunswick are nine in number [illegible] New Jersey, one in Maine, one in Pennsylvania, [illegible]. These manufacturers were desirous [illegible] crude rock, imposed by the tariff [illegible] 1897 [illegible] principal being the United States Gypsum Company [illegible] organized under the laws of New Jersey, 1901, for the purpose of consolidating the principal producers of gypsum, and which has since acquired [illegible] different plants throughout the middle west, were anxious to increase the duty of 1897 on both the crude rock and on the manufactured product. It was claimed by them that under existing conditions their products could not reach within 400 miles of the Atlantic sea-board, while at the same time the eastern product was invading their market. It was also shown by the opposite side that it was the finer grades, that could only be manufactured from Nova Scotia and New Brunswick gypsum, and could not be supplied from the west that were in active competition.

The manufacturer of domestic gypsum can afford to sell his product from $2.50 to $4 per ton at the mill, while the manufacturers of imported gypsum claim they cannot afford to sell at less than $6.50 per ton at the mill.

It was also brought out before this committee that the object of the United States Government was not to prohibit the importation of gypsum but rather to encourage it for revenue purposes.

It was also shown that, although the importation of crude rock had increased under the duty of 1897, it was not as much as it could have been had the duty been less, and that the importation of the manufactured article had fallen off materially. The decision reached by this committee was that it was advisable to reduce the duty on crude gypsum from 50 cents to 30 cents per ton, and on the manufactured product from $2.25 to $1.75 per ton.

F. B. Vandegraft's schedule of United States duties (1909) gives the following items referring to gypsum importation:—

Paragraph.	—	
114	Gypsum block, rough (T.D. 9149, 10132, 226319)......	10c. per cubic foot
114	" blocks, dressed......	50 per cent.
88	" crude (T.D. 26513)......	30c. per ton.
88	" ground or calcined (abt. 562, T.D. 9950, 25067)......	$1.75 per ton
95	" manufactured, n.s.p.f......	35 per cent.
95	" or selenite plates......	35 per cent

Canadian Tariff on Gypsum.

The duty relating to the importation of gypsum into Canada is given in Schedule A, Canada Customs Tariff of 1907, as follows:—

Tariff Item	—	Preferential Tariff.	Intermediate Tariff.	General Tariff
292	Gypsum, crude (sulphate of lime)......Free			
293	Plaster of Paris, or gypsum, calcined and prepared wall plaster, the weight of package to be included in weight for duty......per 100 pounds	8c.	11c.	12½c
294	Plaster of Paris or gypsum, ground, not calcined......per 100 pounds	10 p.c.	12½ p.c.	15 p.c

In 1909 the Board of Customs rendered the following decision: 'Gypsum crushed, whether larger than will pass through a ½" screen or not, will come under item 294.'

St. Peter Canal.

This canal, connecting the southern part of Bras d'Or lakes with the Atlantic ocean, is an important point for consideration to those interested in the gypsum deposits bordering on these lakes.

Its total length is half a mile, its width 48 feet, depth of water 18 feet with one lock 200 feet long. It will be noticed that it has not sufficient capacity for anything but small shipping. This is to be regretted, as it is the natural outlet for a number of excellent gypsum deposits on these lakes, as those at River Tom, Black river, East bay, McKinnon harbour, all south of the Grand Narrows bridge, while there are many other deposits north of that bridge that would use the St. Peter Canal route to advantage.

Gypsum Mining in the United States.

To give an idea of how well some of the American gypsum properties are equipped, the following description, by permission of the author, Mr. W. J. Jones, is given of a gypsum mine near Akron, N.Y.

'The gypsum found in the neighbourhood of Akron, N.Y., occurs in separate basins, in the form of veins which vary in thickness from 3 feet to 4½ feet, and which are found at depths from the surface varying from 50 to 70 feet.

'The Oakfield deposit, or basin as it is usually called, is situated 12 miles east of the Akron field, and in that region the gypsum has been mined for the past 12 or 15 years. Formerly, the method of working was to sink a shaft and then to gopher out around it for a distance of 400 to 500 feet from the shaft, taking out as much as possible of the gypsum deposit regardless of pillars, or the life of the property. All cars were pushed by hand to the foot of the shaft, and when the distance from the bottom of the shaft became too great for the cars to be pushed easily, and when the lives of the men were in danger through lack of suitable pillars, the mine would be abandoned, and another shaft sunk in a nearby location, and similarly worked.

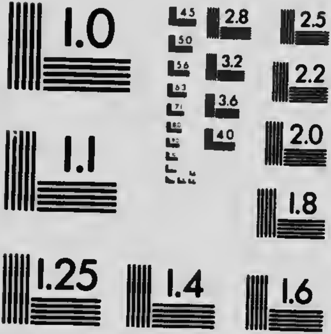
'The room and pillar system of working was introduced into the Oakfield region by Mr. George Hand, of Wilkesbarre, and Mr. Richard Harries, of West Pittston, Pa., both of whom had had experience in the anthracite coal field. This system is now very successfully carried on. At this mine no coal is used to generate steam for power purposes, as all the machinery is operated by electric power brought from Niagara Falls over a three phase, 25 cycle, transmission line, which conveys the current at 11,000 volts to a concrete transformer building, where it is reduced to 440 volts for use in connexion with the different motors about the plant. An 85 horse-power motor drives, by means of a belt, an Ingersoll-Rand No. 10 Imperial compressor, which furnishes power for the pump at the foot of the shaft, and for 10 Howell's No. 2, air drilling machines. Each of these drills cuts from 20 to 35 holes 6 feet deep per day.

'Since the introduction of the newer system of working, there has been a great increase in production, and while just one year ago the output of the mine was from 35 to 60 tons per day, it now amounts to 250 to 300 tons, and with the addition of two or three additional drilling machines, an output of 400 tons will be reached. The gangways in the mine are driven 6 feet, and 18 feet wide, that is, wide enough to hold the bottom rock that must be taken up in order to get sufficient height for electric haulage, as no mules will be used in the mine. The labourers will push the cars from the face to the mouth of the chambers, or to side tracks which will be located every 300 feet along the gangway, and from these side tracks electric locomotives will take the cars to the bottom of the shaft. The rooms are driven 24 feet wide, 300 feet long, and 4 feet high or to the thickness of the vein. The pillars are 24 feet wide, and cross-cuts 20 feet wide are driven 40 and 60 feet apart, alternately, giving two lengths of pillars.

'The gypsum is loaded by the labourer into a steel car, holding about 2,200 pounds, and at the foot of the shaft these cars are side dumped into a steel hopper, from which the gypsum passes into a vertical Jeffrey bucket elevator 110 feet long, containing 175 buckets, and travelling at the rate of 80 feet per minute, which runs in one compartment of the shaft, and delivers it to a Jeffrey

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

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Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

crusher, which crushes the material so that the largest size coming from it is about the size of ordinary pea coal. From the crusher, the product falls into a 400 ton bin, from which it is loaded into box cars for shipment to the cement mills of New Jersey and Pennsylvania. The crusher and conveyer are driven by a 100 horse-power General Electric motor, and they have a capacity for handling all the output that can possibly be produced by the mine.

'The mine is thoroughly ventilated by a 9 ft. exhaust fan, made by the Buffalo Forge Co., driven by a 9½ horse-power motor. The shaft has three compartments, the eastern compartment being used by the bucket elevator, as already noted. In the middle compartment there is an Otis automatic elevator, used for hoisting men, materials, etc., which can be operated by any one by simply pulling the operating cable about 6", as is done at an ordinary elevator in a building. When the cage reaches the top or bottom landing it stops automatically. The west shaft compartment is used for the return air-way leading to the fan, and in this 3 feet have been partitioned off at one end by matched boards, and in this section a very convenient stairway has been placed for the convenience of the men when the elevator is not in use. The foot of the shaft is well lighted by 22 electric lights.'

Minerals Associated with Gypsum.

In the territory under consideration, small quantities of accessory mineral of various kinds are often found, as coal in small veins, but of no commercial value, in the Hillsborough gypsum deposits. Some very fine crystals of pyrolusite have been found at Etang du Nord and Demoiselle hill, in the Magdalen Islands deposits, attached to the gypsum in situ. Crystals of native sulphur are occasionally found in the Wentworth quarries. In the old McDonald and Allison quarries, at Avondale, lumps of rock salt weighing from one to two pounds have been found; also glauber salt, calcspar, arragonite, carbonate and oxide of iron.

The late Dr. How made a careful study of the minerals associated with the gypsum deposits of Hants county, and made some very interesting discoveries. In 1857 he first discovered a mineral previously known only in Peru, and called it natroborocalcite, now known as ulexite, or tiza. He also discovered two other somewhat similar minerals, and designated them cryptomorphite and silicoborocalcite. This last mentioned mineral was afterwards named by Dana, howlite, in honour of the discoverer.

The composition of these minerals is shown in the following analyses made by Dr. How:—

—	Ulexite (Tiza of Peru) — Natroboro-calcite.	Crypto-morphite.	Howlite (Dana) — Silicoboro-calcite.
Lime	14·20	15·55	28·69
Soda	7·21	5·61	none.
Water	34·49	19·72	11·84
Silica	none.	none.	15·25
Boracic acid	44·10	59·12	44·22
	100·00	100·00	

PLATE XXXVI.

Howlite associated with gypsum, from Windsor, N.S.

289—p. 150

These compounds of bor[illegible] found by Dr. How in the gypsum deposits at Wentworth, Windsor, Newport Station, Cheverie, Walton and Noel, and the writer found ulexite in the deposits at Brookfield, Colchester county, and a good specimen of howlite at Windsor.

These minerals occur in crystals and nodules, from small grains up to 2″ in diameter, and seem to be irregularly distributed throughout the deposits. The ulexite is generally found in small soft white silky nodules [illegible] the rock, and also on the surface, among the crystals of selenite. The howlite [illegible] nodules or tufts is pearly white and crystalline.

These minerals are largely used for the manufacture of borax, and for glazing purposes. Samples for the latter purposes, from Windsor, have been tested in Nova Scotia, and England, with excellent results.

With these important minerals occurring in so many of the prominent gypsum deposits of Nova Scotia, it would seem probable that if systematic and intelligent prospecting was carried on, some of these districts would develop deposits of borates of commercial value.

Plaster Setting.

As has previously been noted, different gypsum products can be prepared so that the time required for them to set may be a few minutes or it may be hours. This time of setting in plasters is divided into two periods, the initial set, and the final set, which may be determined in the same manner as in Portland cements, by the Vicat needle, which carries a given constant weight against a small pat of standard size of properly mixed plaster. When this needle, under a load of 50 grammes, fails to pierce half way through the pat, it is said to be the beginning of this initial set. When the weight is increased to 300 grammes and the needle fails to sink into the mass, the final set is said to take place. This is the usual method of making the determinations in cement laboratories, and the instrument is perfectly adapted for the work, but perhaps more expensive than the ordinary mill operator requires for general practice. A more simple apparatus is easily made by placing two wires perpendicularly in a wooden frame, and arranged separately so that each can hold a weight on its top end and move freely in a vertical position, giving a direct pressure on a plaster pat placed beneath. The first wire has a flat area of $\frac{1}{12}$″ and is loaded with a quarter pound weight to determine the initial set; when it fails to make an impression on the plaster pat the set is said to have commenced.

To determine the final set a wire $\frac{1}{24}$″ in area is used, and loaded with a weight of one pound. When the wire makes no impression on the pat the final set has taken place. This apparatus should be kept clean, and used frequently, so that the mill operator can closely watch any unevenness in his product and guard against any such irregularities. Many wall plasters have been condemned by workmen on account of their unevenness in setting; one or more batches may be slow in setting, while possibly the next is quick setting and has reached its final set before the first is floated. In most gypsum quarries the rock is fairly uniform and the trouble referred to is easily guarded against, but where gypsum earth, or gypsite is used for plaster cement, there is more irregularity, and it requires much more careful watching on the part of the mill manager to get an even product.

The mill, however, should not always be blamed in cases of irregularity, as much depends on those mixing and using the material; dirty mixing mortar boxes, with partly set material around the corners, and unclean tools, or sand, or water are often the cause of much trouble. Again, the dry lath will cause much trouble by absorbing the water from the plasters. Seasoned laths should always be well wet before applying plaster mortar. Mortar boxes should be well scraped out, and the scrapings thrown away after each batch is taken out and before starting to mix another. The old mortar starts the crystallization, and acts as an accelerator, causing the mortar to set too quickly. Dirt in the sand or water may act directly as a retarder and cause uneven setting.

Thermometers.

In the previous pages, both Centigrade and Fahrenheit thermometers have been used, and for the convenience of reducing them to one standard, the following rules are given:—

Rule 1. To reduce degrees Centigrade to Fahrenheit, multiply by 9, divide by 5, and add 32.

Formula $\frac{C \times 9}{5} + 32 = F.$

Example: $40\,C \times 9 = 360 \quad \frac{360}{5} = 72 \quad 72 + 32 = 104$ Fahrenheit.

Rule 2. To reduce degrees Fahrenheit to Centigrade, subtract 32, multiply by 5, and divide by 9.

Formula $\frac{F - 32 \times 5}{9} = C.$

Example: $104\,F - 32 = 72 \quad 72 \times 5 = 360 \quad \frac{360}{9} = 40$ Centigrade.

CHAPTER X

Gypsum Statistics.

It will be noticed by the table showing the world's production that the United States now leads in the production of gypsum. Previous to 1906, France was the largest producer; but, while in that country, since 1901, the annual production has been decreasing, in the United States, with the exception of the year 1904, the annual production has been gradually increasing until it now leads the world.

In Canada during the past decade there has been considerable improvement in production, but this improvement, in the Eastern Provinces, has practically all been in the production of crude rock for export purposes. Exclusive of Hillsborough, N.B., which is the largest producer of the manufactured article, and has increased its mill product within the past 10 years over 65 per cent, very little has been done. The Great Northern Mining Company, of Cheticamp, C.B., has only recently started manufacturing, and cannot yet be considered as a large producer, although its prospects for the future are bright.

The import trade has increased much more rapidly in proportion than that of the export business.

In 1900 the total value of imports was $7,519, while that of 1909 was $105,882. By referring to Table No. 11 it will be seen that in 1909 the greatest value ($64,849) is in the importation of plaster of Paris, although crude gypsum forms an important item, being for the same year valued at $35,268.

In the following tables, from 1 to 4 inclusive are taken from 'Mineral Resources of the United States.' Tables from 5 to 11 inclusive were furnished by Mr. John McLeish, statistician of the Division of Mineral Resources and Statistics, Mines Branch, Department of Mines, Ottawa:—

TABLE No. 1.

World's Production.

Year.	France.		United States.		Canada.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		$		$		$
1900	1,761,835	2,722,221	594,462	1,627,203	252,001	259,009
1901	2,182,229	3,449,747	633,791	1,506,611	293,879	340,148
1902	1,975,513	3,318,070	816,478	2,089,341	332,045	356,317
1903	1,798,508	3,134,891	1,041,704	3,792,943	307,489	384,259
1904	1,749,875	2,916,453	940,917	2,784,325	340,761	372,924
1905	1,414,596	2,313,943	1,043,202	3,029,227	435,789	581,543
1906	1,517,603	2,423,615	1,540,585	3,837,975	485,921	646,914
1907	1,547,560	2,544,819	1,751,748	4,942,264	340,964	575,701

Year.	Great Britain.		German Empire.		Algeria.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity	Value.
		$		$		$		$
1900	233,002	348,210	39,103	17,199	41,446	139,190	....	....
1901	224,919	344,650	*b* 35,013	23,139	38,955	132,286	7,784	17,041
1902	251,629	384,263	34,944	12,732	*c* 6,889	52,253	7,874	17,413
1903	246,282	337,391	34,054	19,145	31,967	105,040	11,591	28,796
1904	262,086	354,138	25,095	17,307	33,951	93,287	12,449	31,723
1905	286,169	400,717	....	....	38,297	98,420	17,890	42,499
1906	252,030	362,761	....	....	30,809	85,446	23,069	55,658
1907	....	....	....	....	29,101	75,907	....	

b Includes Baden. *c* Include Tunis.

TABLE No. 2.

The following [illegible] ws the quantity of Crude Gypsum mined in the United States.

	Short tons.		Short tons.
1880	90,000	1895	265,503
1881	85,000	1896	224,254
1882	100,000	1897	288,982
1883	90,000	1898	291,638
1884	90,000	1899	486,235
1885	90,405	1900	594,462
1886	95,250	1901	633,791
1887	95,000	1902	816,478
1888	110,000	1903	1,041,704
1889	267,769	1904	940,917
1890	182,995	1905	1,043,202
1891	208,125	1906	1,540,585
1892	256,259	1907	1,751,748
1893	253,615	1908	1,721,829
1894	239,312		

TABLE No. 3

Production of Gypsum in the United States, 1904-1908, classified as to uses.

Year.	Sold Crude			[illegible]		
	Quantity in short tons.	Value.	Average value per ton.	Quantity in short tons.	Value.	Average value per ton.
		$	$ cts.		$	$ cts.
1904.	56,137	61,23[illegible]	1 [illegible]	[illegible]	142,[illegible]	2 [illegible]
1905.	67,105	106,041	1 58	40,1[illegible]	74,2[illegible]	1 [illegible]
1906.	186,999	460,545	2 46	[illegible]	157,292	2 5[illegible]
1907.	232,546	424,[illegible]27	1 82	46,851	115,841	2 47
1908.	226,261	396,745	1 75	37,672	91,623	2 43

Year.	Sold as Calcined Plaster			Total value.
	Quantity in short tons.	Value.	Average price per ton.	
		$	$ cts.	$
1904.	665,340	2,58[illegible],601	3 88	2,748,521
1905.	736,708	2,848,906	3 87	3,029,227
1906.	899,581	3,220,138	3 58	3,837,975
1907.	1,125,301	4,402,196	3 91	4,942,261
1908.	1,125,617	3,650,192	3 24	4,138,[illegible]

TABLE No. 4.

Disposition of Gypsum in the United States, 1907-8, by uses, in short tons.

	1907.		1908.	
	Quantity.	Value.	Quantity.	Value.
		$		$
Sold crude:—				
For Portland cement	194,535	355,750	187,680	305,745
For paint material	(a)	(a)	1,281	1,300
For plaster material	(b) 36,061	66,597	29,516	77,860
As land plaster	46,851	115,841	37,972	91,833
For other purposes	1,950	1,880	7,484	11,630
Sold calcined:—				
For dental plaster	11,648	24,394	174	636
As plaster of Paris, wall plaster, etc.	1,060,107	4,211,821	1,074,229	3,508,520
To glass factories	5,785	17,164	14,412	41,102
For Portland cement and other purposes	47,761	148,817	36,902	99,934
	1,404,698	4,942,264	1,389,550	4,138,560

(a) Included in 'For plaster material.' (b) Including paint material.

United States Imports.

The gypsum which is imported into the United States comes—except a few hundred tons annually from France and Great Britain—almost wholly from Nova Scotia and New Brunswick, and enters the ports of the New England and North Atlantic states, over one-half of it entering the port of New York. This imported gypsum is nearly all calcined, and converted into wall plasters by plants along the sea-board as far east as Red Beach, Maine. A small quantity of the material is used crude as land plaster, and some is mixed in patent fertilizers.

The following table shows the imports for consumption into the United States from 1904-1908, inclusive, in short tons:—

TABLE No. 5.

Year.	Ground or Calcined.		Unground.		Value of Manufactured Plaster of Paris.	Total Value.
	Quantity.	Value.	Quantity.	Value.		
		$		$	$	$
1904	3,278	11,276	294,238	321,306	23,819	356,401
1905	3,889	20,883	399,230	402,328	22,948	446,152
1906	3,587	22,821	436,999	464,725	21,183	508,729
1907	1,979	12,825	453,911	486,205	36,628	535,658
1908	1,889	12,825	300,158	314,845	26,733	354,403

Canadian Statist[illegible]

There was a notable falling off in the quant[illegible] Can-**ada in 1908, due no doubt** to the general depression [illegible] **1909 showed considerable** improvement, [illegible] total of 456,1[illegible] tons, hav-**ing a value of $798,048**, which is the highest [illegible] recorded.

The following table shows the annual production from 1886 to 1909 inclusive:—

TABLE No. [illegible]

Calendar Year.	Tons.	Value.	Average Price Per Ton.
		$	$ cts
1886	162,000	178,[illegible]42	1 10
1887	154,008	157,277	1 02
1888	175,887	179,393	1 01
1889	213,273	205,108	0 96
1890	226,509	194,033	0 86
1891	203,605	206,251	[illegible] 01
1892	241,048	241,127	[illegible] 00
1893	192,568	196,150	1 02
1894	223,631	202,031	0 90
1895	226,178	202,608	0 89
1896	207,032	178,061	0 86
1897	239,691	244,531	1 02
1898	219,256	232,515	1 06
1899	244,566	257,329	1 05
1900	252,101	259,009	1 02
1901	293,799	340,148	1 16
1902	333,599	379,479	1 14
1903	314,489	388,459	1 24
1904	345,961	373,474	1 08
1905	412,158	586,168	1 32
1906	469,022	643,294	1 37
1907	485,924	646,914	1 33
1908	349,964	575,701	1 69
1909	466,491	798,048	1 7[illegible]

Sales and Shipments of Crude, Ground, and Calcined Gypsum, 1905-1909.

TABLE No. 7.

Year.	Crude (Lump).			Crude (Ground).		
	Tons	Value	Per Ton.	Tons.	Value.	Per Ton.
		$	$ cts.		$	$ cts.
1905	412,155	409,146	99	3,255	8,779	2 70
1906	442,132	473,960	1 07	3,195	9,823	3 07
1907	454,668	473,831	1 04	6,732	16,268	2 42
1908	298,188	307,532	1 03	9,504	25,468	2 68
1909	416,836	445,454	1 07	8,814	26,159	2 97

Year.	Calcined.			Total Sales.		
	Tons.	Value.	Per Ton.	Tons.	Value.	Average per ton.
		$	$ cts.		$	$ cts.
1905	26,748	168,243	6 29	442,158	586,168	1 32
1906	23,695	159,511	6 73	469,022	643,294	1 37
1907	24,521	156,815	6 40	485,921	646,914	1 33
1908	33,272	242,701	7 29	340,964	575,701	1 69
1909	40,841	326,435	7 99	466,491	798,048	1 71

1.

TABLE No.

Annual Production by Provinces

Calendar Year.	Nova Scotia.		New Brunswick.		[illegible]			
	Tons.	Value.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		$		$				
1887	116,346	116,346	29,102	[illegible]	[illegible]	[illegible]		
1888	124,818	120,429	[illegible]	48,764	6,700	[illegible]		
1889	165,025	142,850	40,866	49,130	[illegible]	[illegible]		
1890	181,285	154,972	39,024	[illegible]	[illegible]	[illegible]		
1891	[illegible]	153,955	[illegible]	[illegible]	[illegible]	[illegible]		
1892	[illegible]	170,021	39,709	65,707	1,520	[illegible]		
1893	2,754	144,111	36,916	41,846	2,898	[illegible]		
1894	8,300	147,644	72,962	48,200	[illegible]	6,187		
1895	[illegible]	133,929	66,949	63,839	2,426	4,840		
1896	136,590	111,251	67,137	79,024	[illegible]	7,786		
1897	155,572	121,754	82,658	[illegible]	1,461	4,661		
1898	132,086	106,610	86,083	121,704	1,087	4,201		
1899	126,754	102,055	116,792	151,296	1,020	3,978		
1900	138,712	108,828	112,294	145,850	1,095	4,431		
1901	170,100	136,947	121,595	189,709	[illegible]	5,092	600	[illegible]
1902	206,087	181,425	124,041	179,153	1,917	7,690	[illegible]	20,292
1903	189,427	173,881	119,182	172,080	2,720	21,988	3,160	20,510
1904	218,580	153,600	190,991	187,524	2,300	18,350	4,000	14,000
1905	272,252	298,248	165,553	252,586	4,853	23,834	1,500	[illegible]
1906	333,312	345,414	131,246	250,900	2,965	24,120	3,200	22,500
1907	357,411	380,859	118,106	213,658	10,404	52,317		
1908	234,455	230,433	81,620	191,312	10,349	42,456	14,500	[illegible]
1909	345,682	364,379	92,078	215,391	11,731	48,278	17,000	170,000

TABLE No. 9.

Exports of Crude Gypsum.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1874	67,830	68,164	....	....	....	....	67,830	68,164
1875	86,065	86,193	5,420	5,420	....	....	91,485	91,613
1876	87,720	87,590	4,925	6,616	120	180	92,765	94,386
1877	106,950	93,867	5,030	5,030	....	....	111,980	98,897
1878	88,631	76,695	16,335	16,435	489	675	105,455	93,805
1879	95,623	71,353	8,791	8,791	579	720	104,993	80,864
1880	125,685	111,833	10,375	10,987	875	1,240	136,935	124,060
1881	110,303	100,284	10,310	15,025	657	1,040	121,270	116,349
1882	133,426	121,070	15,597	24,581	1,249	1,946	150,272	147,597
1883	145,448	132,834	20,242	35,557	462	837	166,152	169,228
1884	107,653	100,446	21,800	32,751	688	1,254	130,141	134,451
1885	81,887	77,898	15,140	27,730	525	787	97,552	106,415
1886	118,985	114,116	23,498	40,559	350	538	142,833	155,213
1887	112,557	106,910	19,942	39,295	225	337	132,724	146,542
1888	124,818	120,429	20	50	670	910	125,508	121,389
1889	146,204	142,850	31,495	50,862	483	692	178,182	194,404
1890	145,452	139,707	30,034	52,291	205	256	175,691	192,254
1891	143,770	140,438	27,536	41,350	5	7	171,311	181,795
1892	162,372	157,463	27,488	43,623	....	....	189,860	201,086
1893	132,131	122,556	30,061	36,706	....	....	162,192	159,262
1894	119,569	111,586	40,843	46,538	....	....	160,412	158,124
1895	133,369	125,651	56,117	67,593	....	....	189,486	193,244
1896	116,331	109,054	64,946	77,535	....	....	181,277	186,589
1897	122,984	116,665	66,222	80,485	....	....	189,206	197,150
1898	99,215	93,474	70,399	81,433	....	....	169,614	174,907
1899	104,795	99,984	96,831	108,094	(b) ½	12	201,626	208,090
1900	115,678	....	87,729	....	....	....	188,262	201,912
1901	122,281	....	95,840	....	....	....	236,247	231,594
1902	135,637	....	98,760	....	....	....	289,600	295,215
1903	175,850	....	95,967	....	....	....	287,496	311,589
1904	181,166	(a)	94,648	(a)	....	....	298,211	316,436
1905	197,292	....	127,754	....	....	....	359,246	388,474
1906	247,840	....	102,676	....	....	....	404,464	462,814
1907	332,345	....	86,760	....	....	....	375,026	424,794
1908	242,535	....	55,126	....	....	....	280,091	324,571
1909	299,045	....	71,086	....	....	....	315,201	372,286

(a) Not available. (b) Exported from British Columbia.

TABLE No. 10.

Exports of Ground Gypsum.

Calendar Year.	Nuva Scotia.	New Brunswick.	Ontario.	Total.
	$	$	$	$
1890				105
1891				588
1892				20,255
1893				22,132
1894	2,124	17,930		20,054
1895	3,364	18,827	42	22,233
1896	1,270	19,246	751	21,267
1897	1,655	5,024	84	6,763
1898	1,548	4,900		6,448
1899	205	7,898	20	8,123
1900				19,834
1901				15,337
1902				5,101
1903				12,457
1904				2,333
1905				2,673
1906				2,934
1907				557
1908				9,765
1909				2,787

TABLE No. 11.

Imports.

Fiscal Year.	Crude Gypsum.		Ground Gypsum.		Plaster of Paris.	
	Tons.	Value.	Pounds.	Value.	Pounds.	Value.
		$		$		$
1880	1,854	3,203	1,606,578	5,948	667,676	2,376
1881	1,731	3,442	1,544,714	4,676	574,006	2,864
1882	2,132	3,761	759,460	2,576	751,147	4,184
1883	1,384	3,001	1,017,905	2,579	1,448,650	7,867
1884		3,416	687,432	1,936	782,920	5,226
1885	1,353	2,354	461,400	1,177	689,521	4,809
1886	1,870	2,429	224,119	675	820,273	5,463
1887	1,557	2,492	13,266	73	594,146	4,342
1888	1,236	2,193	106,068	558	912,338	6,662
1889	1,360	2,472	74,390	372	1,173,996	8,513
1890	1,050	1,928	434,400	2,136	693,435	6,004
1891	376	640	36,500	215	1,035,605	8,412
1892	626	1,182	310,250	2,149	1,166,200	5,595
1893	496	1,014	140,830	442	552,130	3,143
1894		1,660	23,270	198	422,700	2,386
1895	603	960	20,700	88	259,200	1,619
1896	1,045	848	64,500	198	297,000	2,000
1897		772	45,000	123	969,900	4,489
1898	1,147	1,742	35,700	293	329,600	2,025
1899	325	692	33,900	338	496,300	3,120
1900	77	958	6,300	69	849,100	6,492
1901	286	1,125	65,400	1,097	502,200	3,978
1902	541	1,697	56,700	249	475,300	2,641
1903	1,076	2,187	68,700	228	630,800	3,599
1904	249	663	106,800	559	625,100	2,885
1905	2,344	7,386	2,255,700	2,681	7,924,100	37,643
1906	6,332	22,008	1,968,600	1,799	12,866,500	43,742
1907 (9 mos.)	9,189	23,410	609,600	1,519	19,849,400	58,364
1908	9,393	36,510	382,500	1,781	15,020,000	51,328
1909	10,317	35,268	6,286,200	5,765	17,009,000	64,849

APPENDIX I.

List of maps and drawings relating to this report which are on file at the office of the Mines Branch of the Department of Mines.

MAPS.

Nova Scotia.

1. Pleasant Bay Sheet, Inverness County.
2. Aspy Bay Sheet, Victoria County.
3. Ingonish Sheet, Victoria County.
4. Cheticamp Sheet, Inverness County.
5. Margaree Sheet, Inverness County.
6. Northeast Margaree Sheet, Inverness County.
7. Broadcove Marsh Sheet, Inverness County.
8. Southwest Margaree Sheet, Inverness County.
9. Ross Section Sheet, Inverness County.
10. Inverness Sheet, Inverness County.
11. Mabou Sheet, Inverness County.
12. Smith Island Sheet, Inverness County.
13. Middle Bridge Sheet, Inverness County.
14. River Denys Sheet, Inverness County.
15. Malagawatchkt Sheet, Inverness County.
16. McKinnon Harbour Sheet, Inverness and Victoria Counties.
17. Nyanza Sheet, Victoria County.
18. Port Bévis Sheet, Victoria County.
19. Island Point Sheet, Victoria County.
20. Saint Ann Sheet, Victoria County.
21. Saunders Cove Sheet, Cape Breton County.
22. East Bay Sheet, Cape Breton County.
23. River Tom Sheet, Richmond County.
24. Black River Sheet, Richmond County.
25. Madame Island Sheet, Richmond County.
26. Askilton Sheet, Inverness and Richmond Counties.
27. Tracadie Harbour Sheet, Antigonish County.
28. Pomquet Harbour Sheet, Antigonish County.
29. Antigonish Harbour Sheet, Antigonish County.
30. Westville Sheet, Pictou County.
31. Bridgeville Sheet, Pictou County.
32. Malagash Sheet, Cumberland County.
33. Pugwash Sheet, Cumberland County.
34. River Philip Sheet, Cumberland County.
35. Springhill Mines Sheet, Cumberland County.
36. Nappan Sheet, Cumberland County.
37. Parrsboro Sheet, Cumberland County.
38. East Mountain Sheet, Colchester County.
39. Shorts Lake Sheet, Colchester County.
40. Shubenacadie River Sheet, Colchester and Hants Counties.
41. Maitland Sheet, Colchester and Hants Counties.
42. Noel Sheet, Hants County.
43. Walton Sheet, Hants County.
44. Cheverie Sheet, Hants County.
45. Avon River Sheet, Hants County.
46. Clarksville Sheet, Hants County.
47. Ninemile River Sheet, Hants County.
48. Elmsdale Sheet, Halifax and Hants Counties.
49. Gay River Sheet, Hants, Halifax, and Colchester Counties.
50. Musquodoboit Sheet, Halifax County.
51. Stewiacke River Sheet, Colchester County.
52. Newton Mills Sheet, Colchester County.

Map showing Great Northern Mining Company's works and quarries, and geological relations of gypsum deposits, Cheticamp, N.S.

New Brunswick

1. **Plaster Rock Sheet,** Victoria County.
2. **St. Martins Sheet,** Kings and St. John Counties.
3. **Sussex Valley Sheet,** Kings and Westmorland Counties.
4. **Hillsborough Sheet,** Albert and Westmorland Counties.

Plan showing workings on Lease No. 2, Wentworth Gypsum Co., Demoiselle **creek, N.B.**

Plan of tunnel at Demoiselle creek, N.B., Wentworth Gypsum Co.

Chart of the Bay of Fundy showing locations of gypsum deposits in its vicinity.

DRAWINGS.

General front view of Olson land plaster distributor.

End dump car and rock slide arrangement.

APPENDIX II.

List of Maps published by the Geological Survey Branch of the Department of Mines, which embrace areas described in this report.

Nova Scotia.

230. Cumberland Coalfield Sheet, 4 miles to 1 inch.
764. Geological Sketch map of parts of Kings and Hants Counties, N.S., 2 miles to 1 inch.
833. Map of Pictou Coal field, 25 chains to 1 inch.
185. Sheet 2. Aspy Bay Sheet, 1 mile to 1 inch.
186. Sheet 3. Pleasant Bay Sheet, 1 mile to 1 inch.
187. Sheet 4. Ingonish Sheet, 1 mile to 1 inch.
188. Sheet 5. Headwaters of Cheticamp River Sheet, 1 mile to 1 inch.
189. Sheet 6. North Cheticamp Sheet, 1 mile to 1 inch.
190. Sheet 7. North Shore Sheet, 1 mile to 1 inch.
191. Sheet 8. Headwaters Margaree River Sheet, 1 mile to 1 inch.
192. Sheet 9. South Cheticamp Sheet, 1 mile to 1 inch.
193. Sheet 10. Englishtown Sheet, 1 mile to 1 inch.
194. Sheet 11. Margaree Sheet, 1 mile to 1 inch.
195. Sheet 12. Baddeck Sheet, 1 mile to 1 inch.
196. Sheet 13. Middle River Sheet, 1 mile to 1 inch.
197. Sheet 14. Broad Cove Sheet, 1 mile to 1 inch.
198. Sheet 15. Whycocomagh Sheet, 1 mile to 1 inch.
199. Sheet 16. Port Hood Sheet, 1 mile to 1 inch.
200. Sheet 17. Loch Lomond Sheet, 1 mile to 1 inch.
201. Sheet 18. River Denys Sheet, 1 mile to 1 inch.
202. Sheet 19. Judique Sheet, 1 mile to 1 inch.
203. Sheet 20. L'Ardoise Sheet, 1 mile to 1 inch
204. Sheet 21. Saint Peter Sheet, 1 mile to 1 inch.
205. Sheet 22. Strait of Canso Sheet, 1 mile to 1 inch.
206. Sheet 23. Arichat Sheet, 1 mile to 1 inch.
207. Sheet 24. Guysborough Sheet, 1 mile to 1 inch.
385. Sheet 31. Roman Valley Sheet, 1 mile to 1 inch.
386. Sheet 32. Pomquet Harbour Sheet, 1 mile to 1 inch.
387. Sheet 33 Cape George Sheet, 1 mile to 1 inch.
388. Sheet 34. Antigonish Sheet, 1 mile to 1 inch.
389. Sheet 35. Lochaber Sheet, 1 mile to 1 inch.
598. Sheet 43. Stellarton Sheet, 1 mile to 1 inch.
600. Sheet 44. New Glasgow Sheet, 1 mile to 1 inch.
608. Sheet 45. Toney River Sheet, 1 mile to 1 inch.
609. Sheet 46. Pictou Sheet, 1 mile to 1 inch.
610. Sheet 47. Westville Sheet, 1 mile to 1 inch.
634. Sheet 49. Upper Musquodoboit Sheet, 1 mile to 1 inch
624. Sheet 50. Moose River Sheet, 1 mile to 1 inch.
908. Sheet 55. Gay River Sheet, 1 mile to 1 inch.
635. Sheet 56. Shubenacadie Sheet, 1 mile to 1 inch.
636. Sheet 57. Truro Sheet, 1 mile to 1 inch.
637. Sheet 58. Earltown Sheet, 1 mile to 1 inch.
793. Sheet 59. Tatamagouche Sheet, 1 mile to 1 inch.
794. Sheet 60. Malagash Shett, 1 mile to 1 inch.
795. Sheet 61. Pugwash Sheet, 1 mile to 1 inch.
796. Sheet 62, Wentworth Sheet, 1 mile to 1 inch.
836. Sheet 63. Londonderry Sheet, 1 mile to 1 inch.
837. Sheet 64. Noel Sheet, 1 mile to 1 inch.
878. Sheet 65. Kennetcook Sheet, 1 mile to 1 inch.
1005. Sheet 66. Elmsdale Sheet, 1 mile to 1 inch.
1037. Sheet 73. Windsor Sheet, 1 mile to 1 inch.
879. Sheet 74. Walton Sheet, 1 mile to 1 inch.
838. Sheet 75. Five Island Sheet, 1 mile to 1 inch.
839. Sheet 76. Pleasant Hills Sheet, 1 mile to 1 inch.
840. Sheet 82. Southampton Sheet, 1 mile to 1 inch.
841. Sheet 83. Parrsboro Sheet, 1 mile to 1 inch.
652. Sheet 133. Cape Dauphin Sheet, 1 mile to 1 inch.
653. Sheet 134. Sydney Sheet, 1 mile to 1 inch.

New Brunswick.

144. Sheet 1 S.E. St. John Sheet, 4 miles to 1 inch.
145. Sheet 1 N.E. Grand Lake Sheet, 4 miles to 1 inch
231. Sheet 2 S.W. Andover Sheet, 4 miles to 1 inch.
254. Sheet 2 N.W. Grand Falls Sheet, 4 miles to 1 inch.
230. Sheet 4 N.W. Cumberland Coal field Sheet, 4 miles to 1 inch

INDEX.

A

B

C

H

I

J

K

L

M

N

O

P

CANADA
DEPARTMENT OF MINES
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REPORTS, AND MAPS OF ECONOMIC INTEREST.

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44. Production of Asbestos in Canada during the calendar years 1907 and 1908. Bulletin on—by John McLeish, B.A.
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IN THE PRESS.

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100. The Building and Ornamental Stones of Canada. Report on—by Professor W. A. Parks.

104. Catalogue of Publications of Mines Branch, from 1902 to 1911: containing Tables of Contents, and List of Maps, etc.

110. Western Portion of Torbrook Iron Ore Deposits, Annapolis county, N. S. Bulletin No. 7—by Howells Fréchette, M.Sc.

111. Diamond Drilling at Point Mamainse, Ont. Bulletin No. 6—by A. C. Lane, Ph.D., with Introductory by A. W. G. Wilson, Ph.D.

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118. Mica: Its Occurrence, Exploitation, and Uses. Report on—by Hugh S. de Schmid, M.E.

IN PREPARATION.

91. Coal and Coal Mining in Nova Scotia. Report on—by J. G. S. Hudson.

MAPS.

6. Magnetometric Survey, Vertical Intensity: Calabogie mine, Bagot township, Renfrew county, Ontario—by E. Nyström, M.E., 1904.

13. Magnetometric Survey of the Belmont Iron Mines, Belmont township, Peterborough county, Ontario—by B. F. Haanel, B.Sc., 1905.

14. Magnetometric Survey of the Wilbur mine, Lavant township, Lanark county, Ontario—by B. F. Haanel, B.Sc., 1905.

15. Magnetometric Survey, Vertical Intensity: Iron Ore Deposits at Austin brook, Bathurst township, Gloucester county, N.B.—by E. Lindeman, M.E., 1906.

33. Magnetometric Survey, Vertical Intensity: Lot 1, Concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, M.Sc., 1909.

34. Magnetometric Survey, Vertical Intensity: Lots 2 and 3, Concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, M.Sc., 1909.

35. Magnetometric Survey, Vertical Intensity: Lots 10, 11, and 12, Concession IX, and Lots 11 and 12, Concession VIII, Mayo township, Hastings county, Ontario—by Howells Fréchette, M.Sc., 1909.

36. Survey of Mer Bleue Peat Bog, Gloucester township, Carleton county, and Cumberland township, Russell county, Ontario—by Erik Nyström, M.E., and A. Anrep, Peat Expert.

37. Survey of Alfred Peat Bog, Alfred and Caledonia townships, Prescott county, Ontario—by Erik Nyström, M.E., and A. Anrep, Peat Expert.

38. Survey of Welland Peat Bog, Wainfleet and Humberstone townships, Welland county, Ontario—by Erik Nyström, M.E., and A. Anrep, Peat Expert.

39. Survey of Newington Peat Bog, Osnabruck, Roxborough, and Cornwall townships, Stormont county, Ontario—by Erik Nyström, M.E., and A. Anrep, Peat Expert.

40. Survey of Perth Peat Bog, Drummond township, Lanark county, Ontario—by Erik Nyström, M.E., and A. Anrep, Peat Expert.

41. Survey of Victoria Road Peat Bog, Bexley and Carden townships, Victoria county, Ontario—by Erik Nyström, M.E., and A. Anrep, Peat Expert.

48. Magnetometric Map of Iron Crown claim at Klaanch river, Vancouver island, B.C.—by Einar Lindeman, M.E.

49. Magnetometric Map of Western Steel Iron claims, at Sechart, Vancouver island, B.C.—by Einar Lindeman, M.E.

50. Vancouver island, B.C.—by Einar Lindeman, M.E.

51. Iron Mines, Texada island, B.C.—by E. H. Shepherd, C.E.

52. Sketch Map of Bog Iron Ore Deposits, West Arm, Quatsino sound, Vancouver island, B.C.—by L. Frank.

53. Iron Ore Occurrences, Ottawa and Pontiac counties, Quebec, 1908—by J. White, and Fritz Cirkel, M.E.

54. Iron Ore Occurrences, Argenteuil county, Quebec, 1908—by Fritz Cirkel, M.E.

57. The Productive Chrome Iron Ore District of Quebec—by Fritz Cirkel, M.E.

60. Magnetometric Survey of the Bristol mine, Pontiac county, Quebec—by Einar Lindeman, M.E.

61. Topographical Map of Bristol mine, Pontiac county, Quebec—by Einar Lindeman, M.E.

64. Index Map of Nova Scotia: Gypsum—by W. F. Jennison, M.E.

65. Index Map of New Brunswick: Gypsum—by W. F. Jennison, M.E.

66. Map of Magdalen islands: Gypsum—by W. F. Jennison, M.E.

70. Magnetometric Survey of Northwest Arm Iron Range, Lake Timagami, Nipissing district, Ontario—by Einar Lindeman, M.E.

72. Brunner Peat Bog, Ontario—by A. Anrep, Peat Expert.

73. Komoka Peat Bog, Ontario " "

74. Brockville Peat Bog, Ontario " "

75. Rondeau Peat Bog, Ontario " "

76. Alfred Peat Bog, Ontario " "

77. Alfred Peat Bog, Ontario: Main Ditch profile—by A. Anrep.

78. Map of Asbestos Region, Province of Quebec, 1910—by Fritz Cirkel, M.E.

86. Map showing general distribution of Serpentine in the Eastern Townships—by Fritz Cirkel, M.E.

94. Map showing Cobalt, Gowganda, Shiningtree, and Porcupine districts—by L. H. Cole, B.Sc.

95. General Map of Canada showing Coal Fields. (Accompanying report No. 83—by Dr. J. B. Porter.)

96. General Map of Coal Fields of Nova Scotia and New Brunswick. (Accompanying Report No. 83—by Dr. J. B. Porter.)

97. General Map showing Coal Fields in Alberta, Saskatchewan, and Manitoba. (Accompanying Report No. 83—by Dr. J. B. Porter.)

98. General Map of Coal Fields in British Columbia. (Accompanying Report No. 83—by Dr. J. B. Porter.)

99. General Map of Coal Field in Yukon Territory. (Accompanying Report No. 83—by Dr. J. B. Porter.)

106. Austin Brook Iron Bearing district, Bathurst township, Gloucester county, N.B.—by E. Lindeman, M.E.

107. Magnetometric Survey, Vertical Intensity: Austin Brook Iron Bearing district—by E. Lindeman, M.E.

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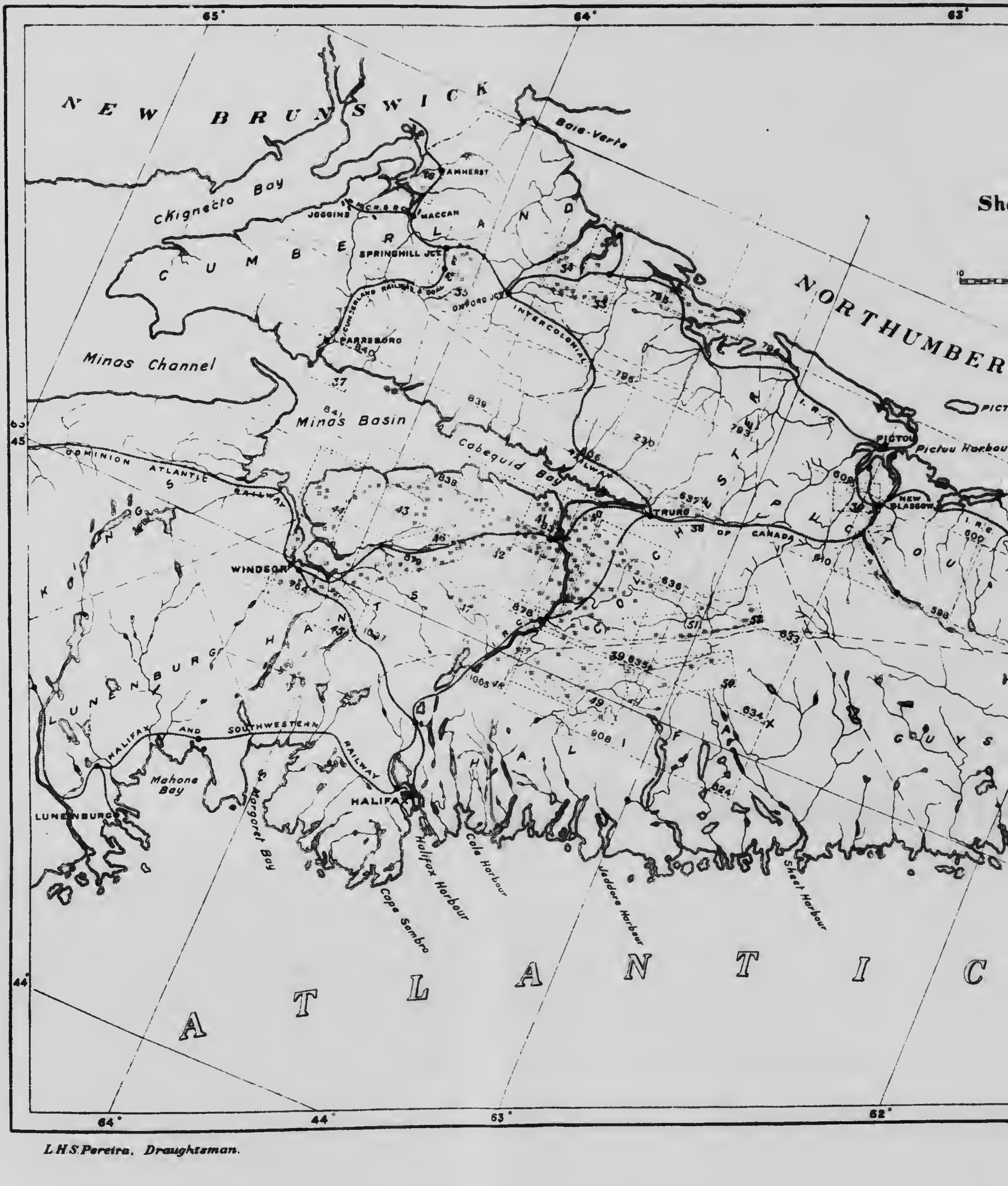

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[...] Haanel, Ph.D., Director.

No 64

To Accompany Report No. 64—
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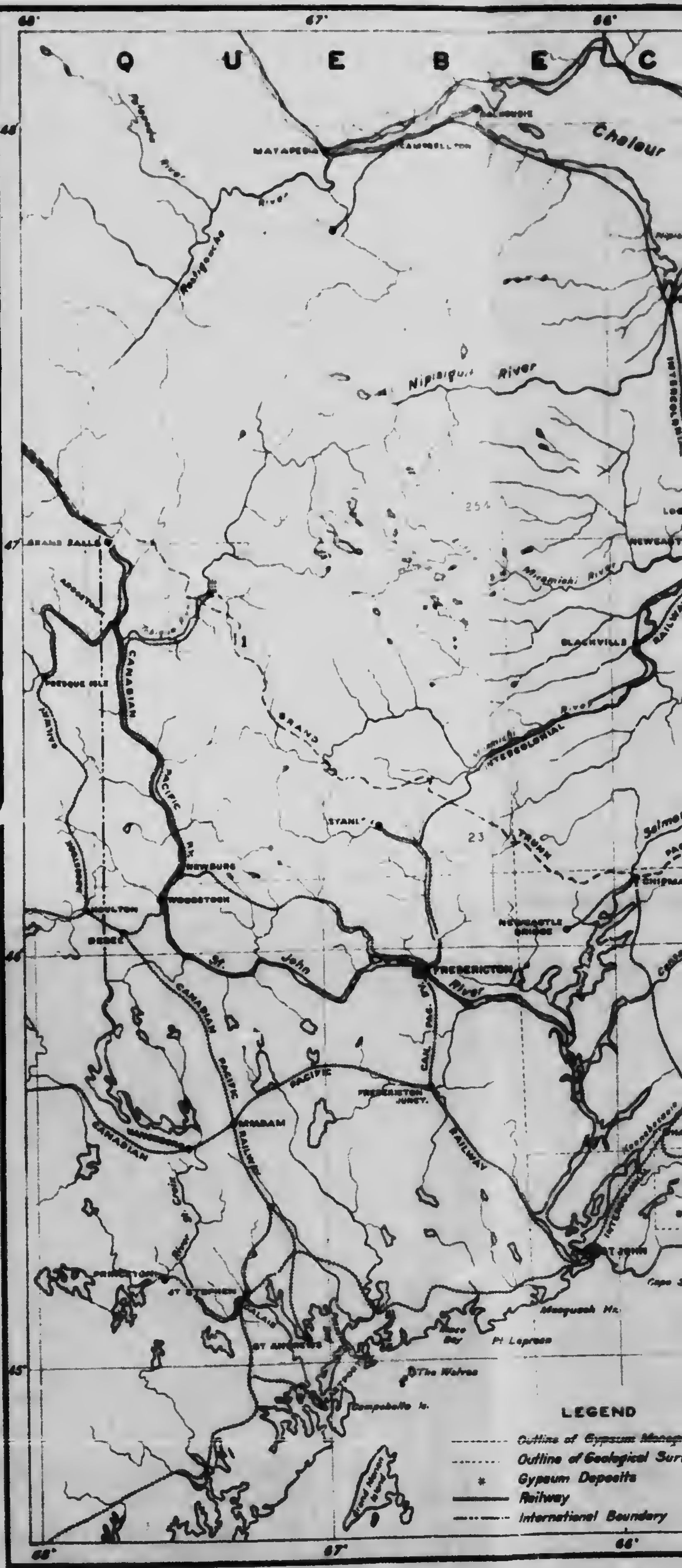

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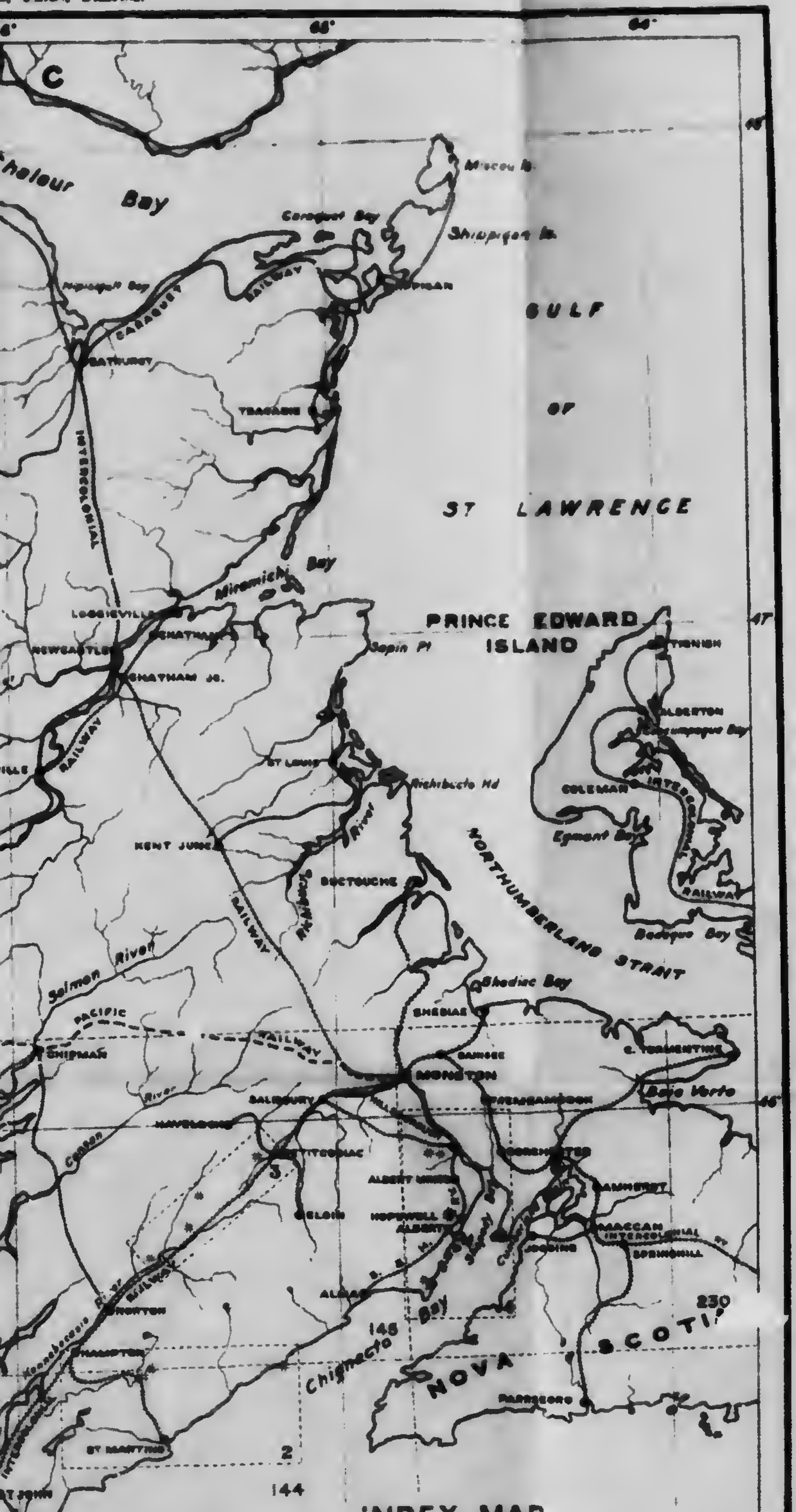

No 65

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Provinces. by W. F. Jennison.

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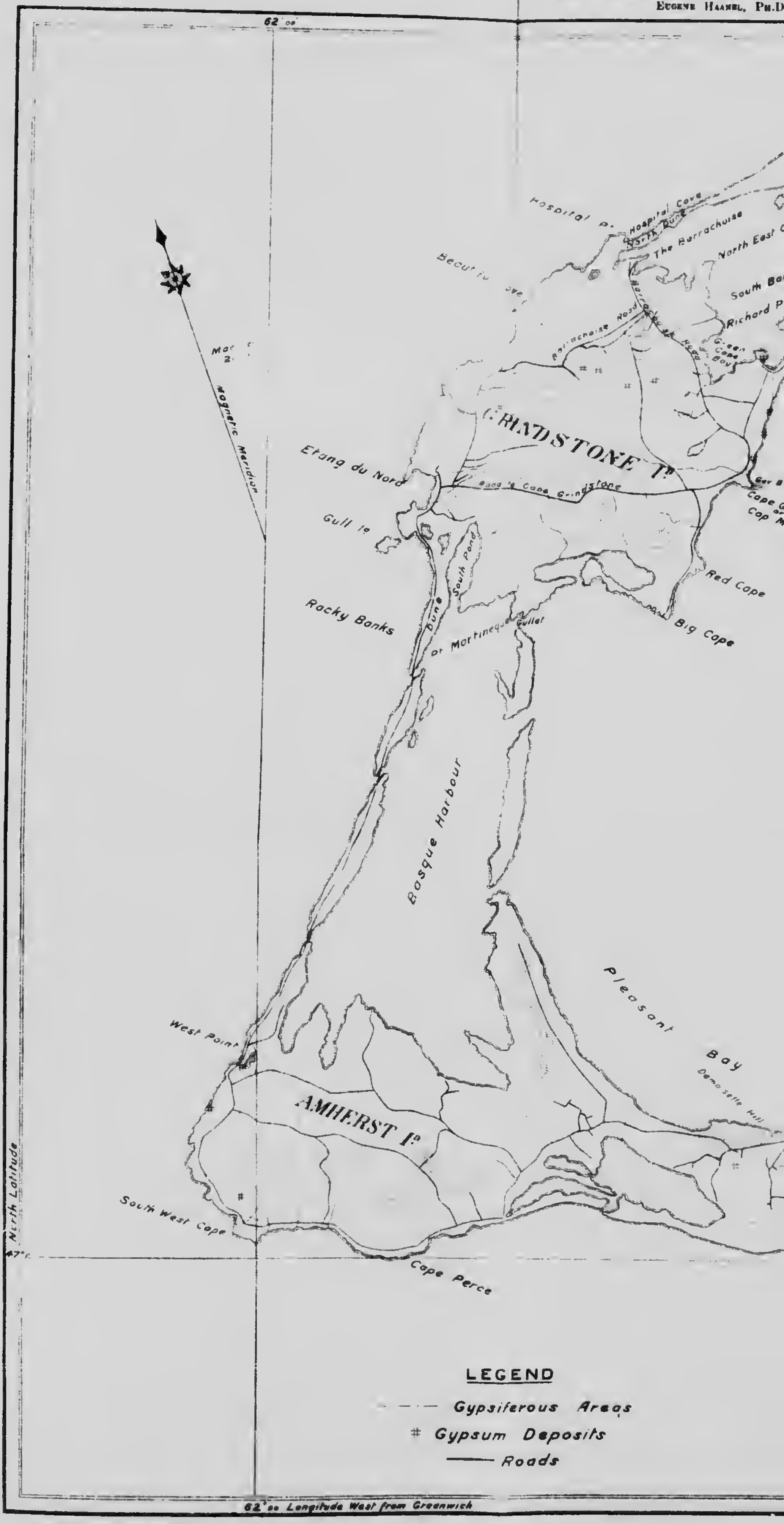

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MAP

OF THE

MAGDALEN ISLANDS

SHOWING GYPSUM DEPOSITS

SCALE OF MILES

No. 66

To Accompany Report No 84—
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Provinces by W. F. Jennison