Conservation of Coal in Canada

W. J. Dick

Commission of Conservation
Canada

Commission of Conservation

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Mr. James White

Commission of Conservation
Canada

COMMITTEE ON MINERALS

CONSERVATION OF COAL IN CANADA

with Notes on the Principal Coal Mines

By

W. J. DICK, M.Sc.

Mining Engineer of the Commission of Conservation

Toronto:
The Bryant Press, Ltd.
1914

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and the Ex-officio Members of the Commission representing the various Provinces.

To Field Marshal His Royal Highness Prince Arthur William Patrick Albert, Duke of Connaught and of Strathearn, K.G., K.T., K.P., etc., etc., Governor-General of Canada.

May it Please Your Royal Highness :

The undersigned has the honour to lay before Your Royal Highness a report on the 'Conservation of Coal in Canada,' compiled by W. J. Dick, M.Sc., Mining Engineer of the Commission of Conservation.

Respectfully submitted

CLIFFORD SIFTON
Chairman

Ottawa, October 8th, 1913

OTTAWA, October 7th, 1913

Sir :

I have the honour to transmit herewith a report on 'Conservation of Coal in Canada,' compiled by W. J. Dick, Mining Engineer of the Commission of Conservation.

Your obedient servant

JAMES WHITE
Assistant to Chairman

HON. CLIFFORD SIFTON
Chairman
Commission of Conservation

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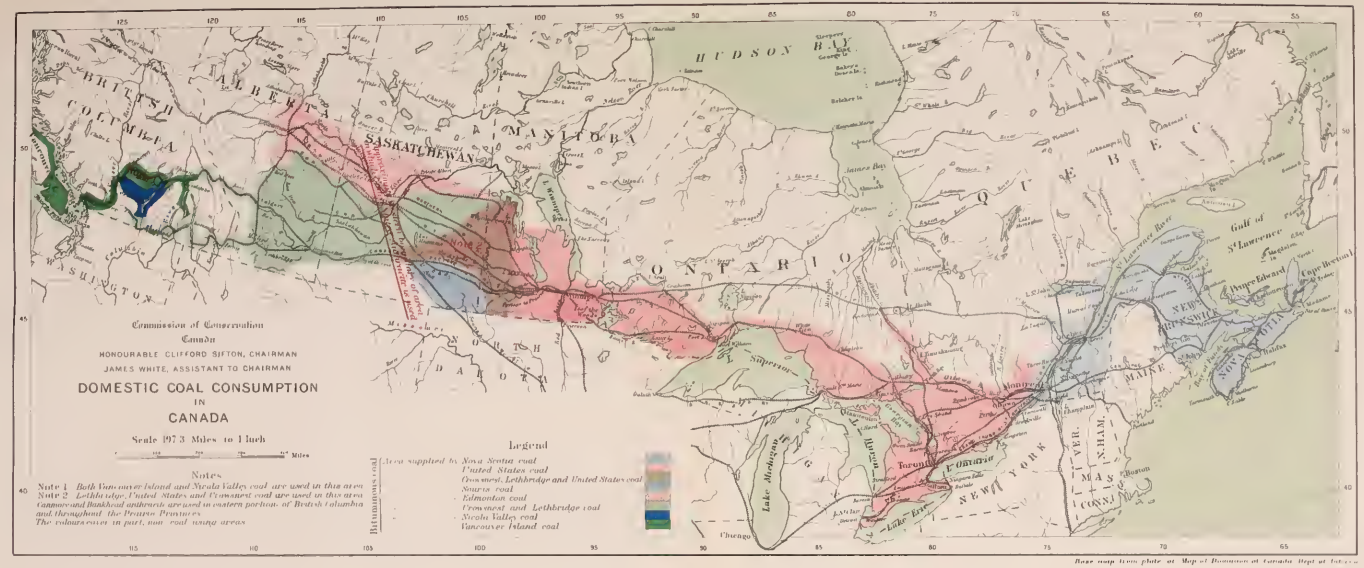


Base map from plate 41 Map of Dominion of Canada Dept of Interior

Conservation of Coal in Canada

COAL-MINING RIGHTS that are the property of the Crown in the provinces of Manitoba, Saskatchewan and Alberta, in Yukon, the Northwest Territories, and in the Railway Belt and the Peace River Block in the province of British Columbia, are disposed of under lease by the Federal Government.*

Coal-Mine Leases

CANADA

The principal provisions embodied in the lease are :

1. The term of lease is 21 years, with the privilege of renewal for a further term of 21 years.

2. The annual rental is $1.00 per acre, payable yearly in advance.

3. No applicant is allowed to lease more than an area of 2560 acres.

4. A lease is subject to cancellation if active operations are not carried on within the time specified. The maximum amount of coal required to be produced within the specified time shall not exceed 10 tons per annum for each acre leased.

5. Actual settlers are entitled to buy coal for their own use at a price not to exceed $1.75 per ton at the pit-head.

6. A royalty of 5c. per ton of 2,000 lbs is levied on the MERCHANTABLE output of the mine.

7. The lease disposes of the coal-mining rights only, but provides for the purchase of the necessary surface rights.

ROYALTY ON OUTPUT.—The provisions of the lease are such as to encourage coal mining and, with one exception, to protect the rights of the people. Levying a royalty on 'merchantable output' is wrong in principle, for, by so doing, the waste of slack coal is encouraged.

RECORDS OF DRILL HOLES.—As leases are issued for coal-mining rights on Crown lands, the records of drill holes should be filed with the Government. These records would be of value to the country,

*Order in Council, April 20th, 1910.

since the Government could obtain from them a knowledge of the adjoining coal lands. They would also prove of value in connection with the study of the stratigraphy of the region.

On account of the importance of coal from a national standpoint, it is necessary that records be kept giving the percentage extraction of coal, the method of mining employed, and the rate of exhaustion of coal areas. These records would also prove of use in comparing the different methods employed and would thus tend to standardize the mining methods.

The Province of Nova Scotia not only requires all the above information, but also exercises a supervision over the methods of mining employed.*

Austria

In Austria, coal-mining permits are granted to mine operators. The State may also engage in coal mining and, if it does, it is made subject to the same regulations as private operators. In general, the choice of the method of mining is left to the operator, but he is legally bound to mine in an economical manner and to carry on the work in such a way as not to render future mining operations difficult. The State authorities supervise the work and see that no coal is lost by injudicious mining. They may also demand the production of working plans, modify them, and demand that they be observed in their amended form.

Australia

In Australia, the following provisions are embodied in all Crown leases :

The lessee shall extract as large a percentage of the coal or shale in the land leased as is possible consistent with safety. Should 'Pillar and Stall' system of working be adopted the percentage of coal to be left in the pillars, during the construction of the bords, headings or other workings shall be as follows :

Where the depth from the surface does not exceed two hundred and fifty feet, fifty per cent.; from two hundred and fifty to five hundred feet, in the proportion of from fifty to sixty per cent.; from five hundred to one thousand feet, in the proportion of from sixty to seventy per cent.; from one thousand to two thousand feet, in the proportion of from seventy to eighty-five per cent. Such pillars may be subsequently removed unless the Secretary for Mines by writing under his hand shall otherwise direct.

If any question shall arise as to whether a greater amount of coal or shale has been left unworked than is necessary under the foregoing conditions, *the matter shall be decided by the Chief Inspector of Coal Mines, whose decision shall be final.*

*See Appendix I, p. 33 *et seq.*

Japan

In Japan, all unmined minerals (including rejected ores and tailings) are the property of the State. No persons other than subjects of the Empire or companies duly formed in accordance with the laws thereof, are entitled to acquire mining rights. The maximum extent of individual coal-mining rights is a little over 42 acres.

Prospecting rights are given for two years, but the term of a mining right is not limited. Mining taxes are imposed upon all holders of mining rights, and include the taxes imposed upon mining ores and upon mining production. The former is 30 sen (15 cents) per annum for prospecting rights and 60 sen (30 cents) per annum for mining rights for every four-fifths of an acre held under prospecting or mining rights. The tax on production is one per cent. of the value of the mineral produced.

Before mining operations are begun, it is necessary for the holder of a mining right to submit a scheme of intended operations to the Mine Inspection Office. To receive approval, this proposed method of mining must be such as to prevent wasteful mining and must provide for the safety of the miners. Maps of actual surveys of the mine must be submitted to the Government twice a year.

England and Scotland

In England, Scotland, and certain portions of the United States, coal-mining rights are leased from the owners, who appoint mining engineers who pass upon the methods to be employed by the lessee and determine the amount of coal upon which royalty is to be paid.

Engineering Authority Suggested

From the foregoing it can be seen that the governments of Nova Scotia, Austria, Australia and Japan and private owners of coal lands in England, Scotland, and in certain portions of the United States, supervise the methods of mining used. If it is to the advantage of these interests to engage engineers to guard against wasteful methods, surely it would be to the advantage of the Dominion Government to do so. In Western Canada, there are usually a number of coal seams quite close together, and should the lowest seams be the most desirable with regard to quality and ease of working, there is nothing to prevent the operator from mining them first. In fact, this practice is now being followed in a number of cases in the West. As a result, caving of the measures will render it difficult, and, in many cases, impossible, to recover the coal from the upper seams. Owing to the wide distribution of coal and as leases are granted to any one desiring to mine it, the operator who looks to the future and mines the coal

in a systematic manner, at an additional cost to himself, has to compete with the operator who takes the easiest available coal. There is, therefore, little encouragement to use other than wasteful methods. A case came under notice where, owing to a great demand for coal, the directors instructed a mine-manager to produce an output greater than the development work justified. The mine-manager was forced, against his better judgment, to obtain the coal wherever he could. Some pillars were extracted and others were reduced to such dimensions that they were not able to bear the weight of the superincumbent strata. As a consequence, there was a squeeze, and to-day the mine is badly wrecked and much coal has been lost. In this case, the opinion of an engineering authority would have stood between the mine-manager and the directors of the company.

It is proposed that an engineering authority be appointed by the Dominion Government to approve of the methods to be employed at all mines operated under a Dominion Government lease, and, that the chief inspector of mines of each province be associated with the engineering authority in so far as matters relating to the operation of mines in that province are concerned. It would also be the duty of such authority to investigate all applications for leasing of coal lands and to determine the conditions under which such leases should be granted.

It is of interest to note, in this connection, that the Dominion Government exercises a stricter supervision over the leasing of water-powers than that suggested with regard to coal ; yet coal is just as important as water-power and, unlike it, can be exhausted. The following is a *résumé* of the manner in which water-powers are disposed of :—

All water-powers under federal control are leased under strict regulations, and, before the issuance of a license for the development of any particular water-power site, or for the purpose of storing water, the application has to go through three different stages :

First, the plans have to be submitted and approved of by a competent staff (the Water-powers Branch of the Department of the Interior) which has been established for the sole purpose of investigating these proposed water-power developments, particularly from the view-point of maximum efficiency in conjunction with other power sites on the same or tributary rivers.

Second, once the plans have been approved, construction work may proceed under Government supervision.

Third, after the construction work is completed the license is granted for a limited period, the Government reserving the following rights :

(*a*) To renew the licenses or not.

(*b*) To compel the development of sufficient power to satisfy public demands, up to the full extent possible from the amount of water granted.

(*c*) To stipulate that the rates charged the public for power be governed by the Board of Railway Commissioners of Canada.

The Water Powers Branch is not only carrying on this work, but is also investigating and planning possible future developments.

Ascertaining Uses for Low-grade Coals

To encourage the utilization of low-grade coals and in order, also, to prevent the waste of slack coal, investigations should be carried on by the Government to determine the suitability of these classes of coal for use in the gas-producer for generating power and their adaptability for the manufacture of briquettes for domestic use. By utilizing these inferior products in this way, not only would there be less waste, but the value of the public coal lands would be considerably increased.

Waste of Slack Coal.—As a result of an investigation made in 1911, it was found that there was in Saskatchewan, Alberta and British Columbia, a considerable waste of slack coal which had been mined and brought to the surface. This waste of unmarketable slack coal varies from 10 to 35 per cent of the output. In Saskatchewan, 10 to 25 per cent of the output from the mines is slack coal, which is dumped on the ground and wasted. In the vicinity of Estevan, 10 to 12 per cent of the output from some of the larger mines is dumped on the prairie and burned. It is necessary, however, to remove this coal (lignite) from the mine plant as it readily ignites by spontaneous combustion.

The waste of slack coal varies from 10 to 12 per cent in the Lethbridge district, and from 20 to 35 per cent in the Edmonton district. In the Crowsnest Pass district in Alberta and British Columbia, the coal is of better grade and some of the slack is marketable ; the remainder is made into coke in beehive coke ovens. At Bankhead, briquettes are made from it. On Vancouver Island, some of the large producing mines waste from 10 to 15 per cent of their output as slack coal, and, unfortunately, it is generally dumped into the sea. The high freight rates make it impossible to market it at a profit.

Freight Rates on Coal in the West

The accompanying tables and diagrams show the freight rates charged by the railroads on coal from the several coal-mining centres in the West to the principal markets.

Table XII shows the freight rates charged by the railways on United States coal from Fort William westward.

FREIGHT TARIFF ON COAL

I.—FROM FERNIE TO STATIONS ON THE CANADIAN PACIFIC

Station	Distance from Fernie (Miles)	Tariff per ton (Minimum, 40,000 lbs. lot)	Rate per ton-mile* (Mills)
Macleod	105	$1.65	15.7
Lethbridge	141	1.90	13.4
Medicine Hat	242	2.40	9.9
Swift Current	392	3.10	7.9
Moose Jaw	503	3.65	7.2
Regina	544	3.80	7.0
Moosomin	683	4.35	6.3
Brandon	769	4.45	5.7
Portage la Prairie	847	4.60	5.4
Winnipeg	902	4.70	5.2
II.—FROM FERNIE TO EDMONTON, via CALGARY			
Calgary	212	$2.25	10.6
Red Deer	306	2.60	8.5
Wetaskiwin	363	2.95	8.1
Edmonton	405	3.30	8.1
III.—FROM FERNIE TO GREENWOOD, B.C.			
Cranbrook	63	$1.60	25.4
Kootenay Landing	146	2.25	15.4
Nelson	200	2.40	12.0
Castlegar Junct	226	2.60	11.5
Rossland	256	2.60	10.1
Greenwood	317	3.30	10.4
Granby Junct	296	3.20	10.7
IV.—FROM FERNIE TO SASKATOON via WETASKIWIN			
Wetaskiwin	363	2.95	8.1
Hardisty	458	3.40	7.4
Saskatoon	689	4.25	6.2
V.—FROM FERNIE TO NORTH PORTAL via MOOSE JAW			
Moose Jaw	503	$3.65	7.2
Rouleau	534	3.80	7.06
Weyburn	595	4.05	6.8
Estevan	647	4.20	6.5
North Portal	670	4.25	6.34

*2000 lbs.

VI.—FROM EDMONTON TO STATIONS ON THE CANADIAN PACIFIC

Station	Distance from Edmonton (Miles)	Tariff per ton (Minimum, 40,000 lbs. lot)	Rate per ton-mile (Mills)
Wetaskiwin	42	$0.90	21.4
Hardisty	137	1.90	13.87
Macklin	206	2.25	10.92
Saskatoon	368	3.00	8.15
Lanigan	444	3.30	7.44
Yorkton	570	3.95	6.93
Birtle	655	4.25	6.50
Portage la Prairie	793	4.10	5.17
Winnipeg	848	4.10	4.84

VII.—FROM EDMONTON TO STATIONS ON THE GRAND TRUNK PACIFIC

Station	Distance from Edmonton (Miles)	Tariff per ton (Minimum, 40,000 lbs. lot)	Rate per ton-mile (Mills)
Wainwright	126	$1.80	14.3
Biggar	266	2.50	9.4
South Saskatoon	326	2.90	8.9
Watrous	385	3.10	8.05
Nokomis	407	3.20	7.87
Melville	514	3.70	7.20
Rivers	651	4.00	6.15
Portage la Prairie	739	4.00	5.41
Winnipeg	793	4.00	5.04

VIII.—FROM EDMONTON TO STATIONS ON THE CANADIAN NORTHERN

Station	Distance from Edmonton (Miles)	Tariff per ton (Minimum, 40,000 lbs. lot)	Rate per ton-mile (Mills)
Vegreville	73	$1.30	17.8
Lloydminster	170	2.00	11.75
North Battleford	254	2.40	9.45
Warman	336	2.90	8.64
Humboldt	402	3.10	7.74
Kamsack	548	3.80	6.93
Dauphin	649	4.00	6.16
Portage la Prairie	772	4.00	5.18
Winnipeg	827	4.00	4.84

IX.—FROM LETHBRIDGE TO STATIONS ON THE CANADIAN PACIFIC

Station	Distance from Lethbridge (Miles)	Tariff per ton (Minimum, 40,000 lbs. lot)	Rate per ton-mile (Mills)
Medicine Hat	101	$1.60	15.8
Swift Current	251	2.40	9.6
Moose Jaw	362	2.95	8.15
Regina	403	3.10	7.7
Moosomin	542	3.80	7.0
Brandon	628	4.20	6.7
Portage la Prairie	706	4.35	6.16
Winnipeg	761	4.45	5.75
Macleod	36	.90	25.0
Calgary	140	1.80	12.8

X.—FROM BANKHEAD TO STATIONS ON THE CANADIAN PACIFIC

Station	Distance from Bankhead (Miles)	Tariff per ton (Minimum, 40,000 lbs. lot)	Rate per ton-mile (Mills)
Calgary	79	$1.45	18.3
Medicine Hat	260	2.40	9.2
Swift Current	410	3.20	7.2
Moose Jaw	521	3.70	7.1
Regina	562	3.95	7.0
Moosomin	701	4.35	6.2
Brandon	787	4.50	5.7
Portage la Prairie	865	4.65	5.4
Winnipeg	920	4.70	5.1

XI.—FROM BIENFAIT TO STATIONS ON THE CANADIAN NORTHERN

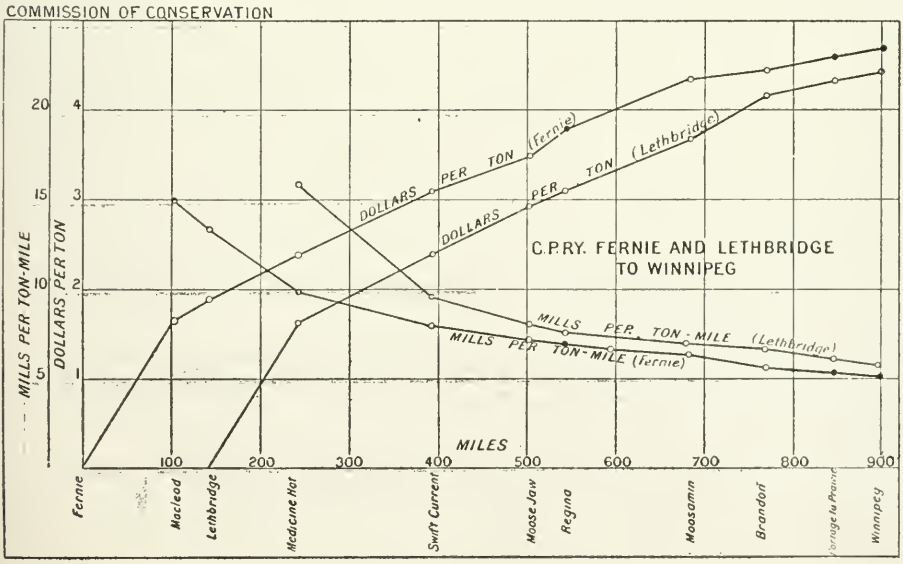
Station	Distance from Bienfait (Miles)	Tariff per ton (Minimum, 40,000 lbs. lot)	Rate per ton-mile (Mills)
Luxton	16	$0.60	37.5
Radville	71	.90	12.6
Moose Jaw (Antar.)	151	1.60	10.6
Maryfield	85	.90	10.5
Kipling	138	1.40	10.1
Regina	230	1.80	7.83
Brandon	161	1.60	9.95
Portage la Prairie	241	1.80	7.47
Winnipeg	297	1.80	6.06
Neepawa	220	1.80	8.18
Dauphin	296	1.80	6.08

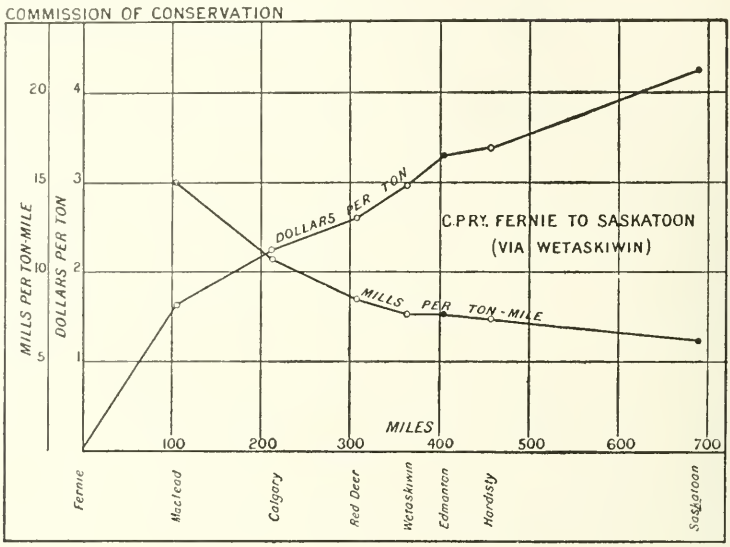
XII.—UNITED STATES COAL

Station	Distance from Fort William (Miles)	Tariff per ton (Minimum, 40,000 lbs. lot)	Rate per ton-mile (Mills)
Winnipeg, by Can. Pac....	420	$2.50	5.9
Winnipeg, by Can. Nor....	436	2.50	5.7
Sioux Lookout, by Gr.Tr.Pac.	196	1.80	9.13
Winnipeg " " "	447	2.50	5.59
Portage la Prairie " "	501	2.90	5.79
Watrous " " "	855	4.30	5.03
South Saskatoon " "	914	4.80	5.25
Wainwright " " "	1114	5.40	4.73

Western Freight Rate Diagrams

The following diagrams illustrate graphically the freight rates charged on coal between different points in Western Canada :

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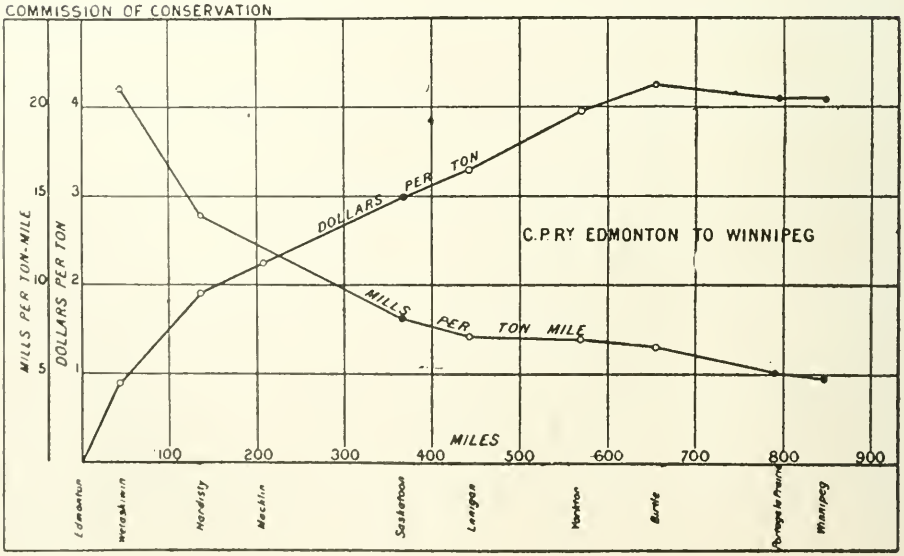
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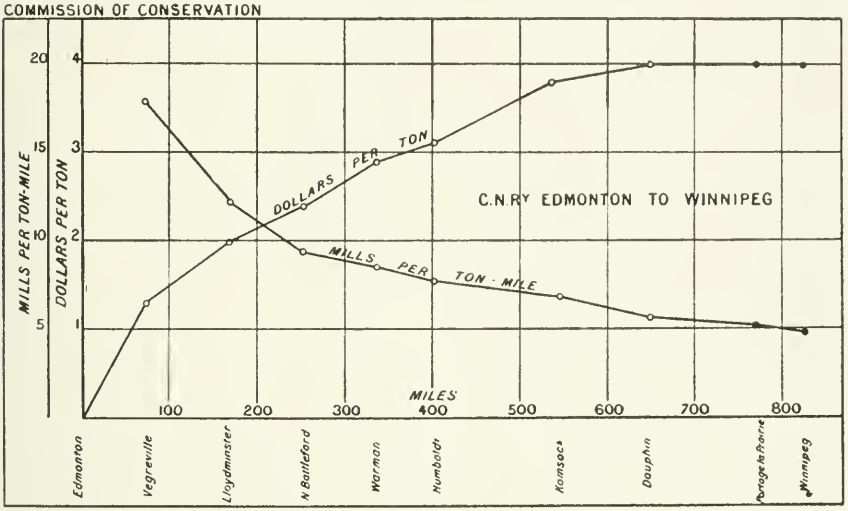
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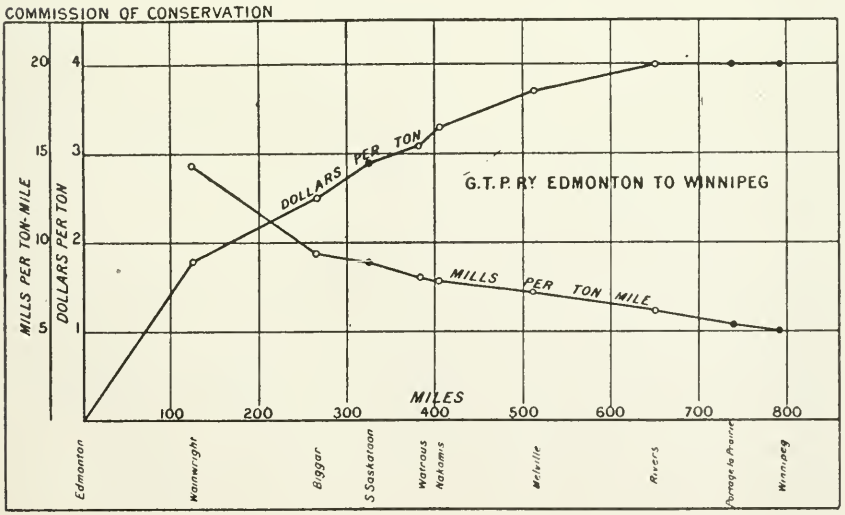
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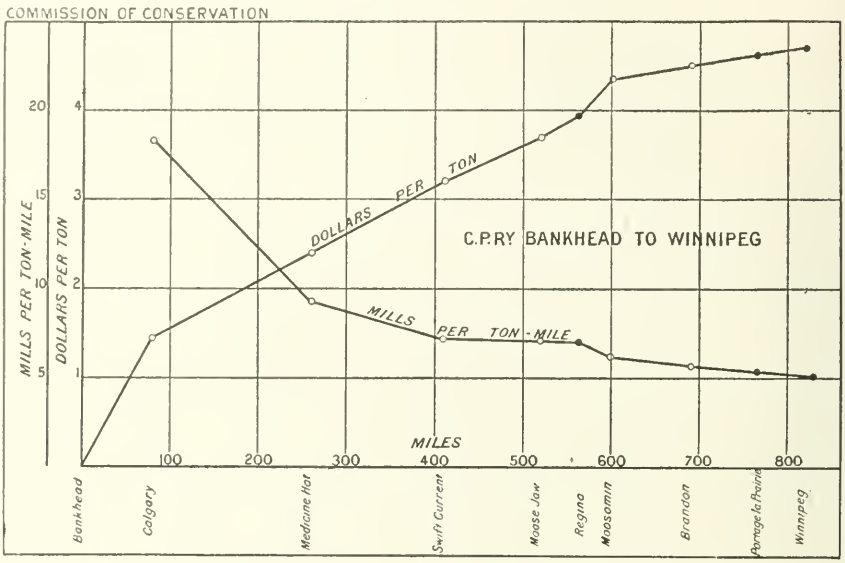
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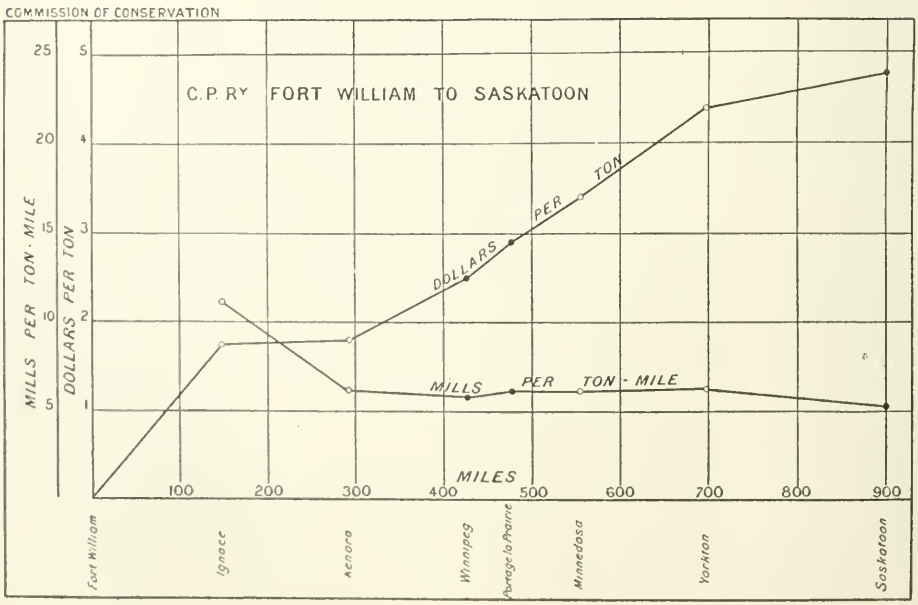
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Kenora
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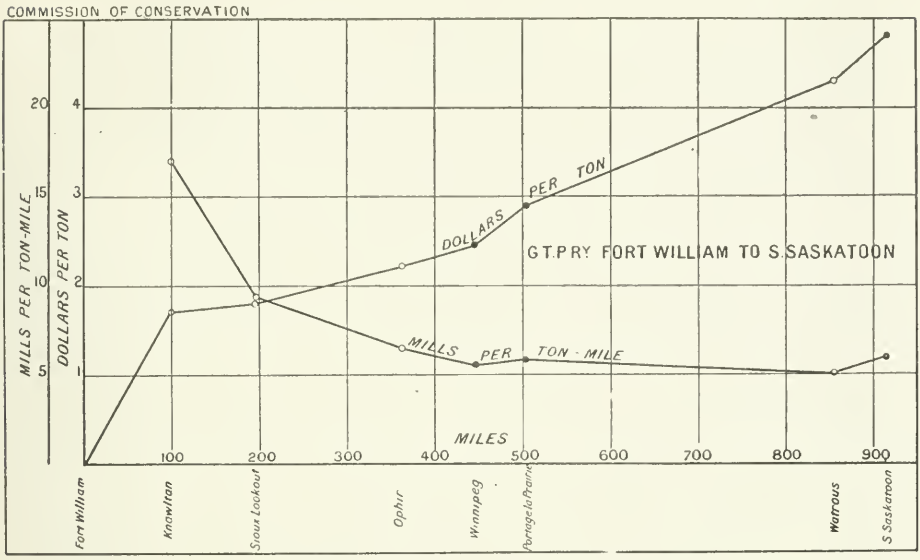
Portage la Prairie
Minnedosa
Yorkton
Saskatoon



Distribution of Coal Sold in Canada

The maps at pages 1 and 32 show the distribution of coal sold in Canada.

With regard to this subject, the following facts are to be noted :

(1) United States anthracite coal is used from Nova Scotia on the east, to Battleford on the west.

(2) Nova Scotia bituminous coal is used only as far west as Cornwall, Ontario.

(3) United States bituminous coal is used from Farnham to a line drawn from Battleford to Moose Jaw and thence to Estevan. Although a considerable quantity of United States coal is used in Manitoba and Saskatchewan, these provinces are also supplied by coal from the Crowsnest, Edmonton, Lethbridge and Souris districts.

Cheap Power Problem

Two problems of great importance exist in the Prairie Provinces to-day, and their solution will become a matter of even greater moment in the future. These are: The problem of cheap power and the problem of a domestic fuel supply.

In parts of Manitoba, Saskatchewan and Alberta water-power cannot be economically developed, but these districts are within reach of great deposits of lignite.

The experience of the United States and Germany has demonstrated that cheap power can be produced in gas engines from lignites inferior to those in the Prairie Provinces, and it is believed that electric energy can be generated from these lignites and supplied to the market cheaper than power generated from coal supplied (as it now is) from the United States and Western Alberta.

Tests of Low-grade Coal in Gas Producers

In the United States—Messrs. R. H. Fernald and C. D. Smith in referring to the production of cheap power in gas producers, in *Bulletin No. 13*, United States Bureau of Mines, say :

These tests in the gas producer have shown that many fuels of such low grade as to be practically valueless for steaming purposes, including slack coal, bone coal, and lignite, may be economically converted into producer gas and may thus generate sufficient power to render them of high commercial value.

Practically every shipment tested in the producers, including coals with ash as high as 44 per cent and lignites and peats high in moisture, has been successfully converted into gas that has been used in operating gas engines. It is estimated that, on an average, each coal tested in the producer-gas plant developed two and one-half times the power that it would develop if used in the ordinary steam-boiler plant. Such relative efficiencies probably hold good for the average installation of moderate power capacity, but the ratio is smaller when large steam plants of the most modern type are compared. It was found that the low-grade lignite of North Dakota developed as much power when converted into producer gas as did the best West Virginia bituminous coal when utilized under the steam boiler. Thus, through these investigations, lignite beds underlying 20,000,000 to 30,000,000 acres of public lands, supposed to be worth little, have been shown to possess a large value for power development. As a result, the money value of this Government land has been increased to the extent of probably $300,000,000, or more.

Investigations into the waste of coal in mining in the United States have shown that it probably aggregates 250,000,000 to 300,000,000 tons yearly, of which at least one-half might be saved. It has been demonstrated that the low-grade coals, high in sulphur and ash, now left underground, can be used economically in the gas producer for the ultimate production of power, heat and light, and should, therefore, be mined at the same time as the high grade coal. Moreover, attention is now being called to the practicability of further reducing this waste through more efficient mining methods.

In Canada.—The following extracts, showing the adaptability of Canadian lignites for use in the gas-producer, are taken from the reports on *Investigation of the Coals of Canada, Part II*,, Mines Branch, Department of Mines :

Seven ordinary gas-producer trials (one a repeat) and one special test were made with the lignites and lignitic coals from Saskatchewan and Alberta. The samples were mined by the Western Dominion Collieries, Ltd., Taylorton, Sask.; Parkdale Coal Co., Ltd., and Standard Coal Co., Ltd., Edmonton, Alta. ; Strathcona Coal Co., Ltd., Strathcona, Alta. ; Canada West Coal Co., Taber, Alta. ; and the Alberta Railway & Irrigation Co., Ltd., Lethbridge, Alta.

These fuels all proved excellent for use in the down-draft producer, most of them required no steam at all, and some gave so little tar that the gas washer could be dispensed with. They all have low calorific values, are moderately high in ash, and contain much intrinsic moisture. They weather rapidly and break up in the producer. Good efficiencies were obtained in each case with gas of high calorific value and uniform in quality. Very little attention to the fire was needed, and, with most of the samples, the producer could have been run without the exhauster as a suction producer. The Belly River coals (Nos. 43 and 44) required slightly more attention than the others, and, on the whole, No. 46 (Strathcona) gave the best results.

In connection with coal No. 2040 (Taylorton lignite), it should be noted that seven weeks (during which the fuel was kept in bags in a dry store) elapsed between trial 8 and trial 17. The change in composition of the lignite during this time is well shown, but the aging process did not seem to make it less suitable for use in the producer.

RESULTS OF TESTS OF LIGNITES AND LIGNITIC COALS

Coal No.	2040	2040	42	45	46	43	44
Description	Lignite from Western Dominion Collieries, Ltd., Taylorton, Sask.		Lignite from Parkdale Coal Co., Ltd., Edmonton, Alta.	Lignite from Standard Coal Co., Ltd., Edmonton, Alta.	Lignite from Strathcona Coal Co., Ltd., Strathcona, Alta.	Lignitic coal from Canada West Coal Co., Ltd., Taber, Alta.	Lignitic coal from Galt Colliery, Alta. Ry. and Irrigation Co., Ltd., Lethbridge, Alta.
	Trial 8	Trial 17					
Vol. matter.....%	32.8	43.3	28.7	31.2	30.9	26.6	35.2
Ash.....%	7.2	11.1	11.2	7.5	11.9	16.3	9.4
Moisture.....%	23.3	13.4	17.3	15.3	16.1	12.6	7.8
Cal. value of coal as charged.....B.T.U.	8300	9370	8940	9610	9010	9650	10800
Cal. value of gas (lower) per cu. ft., B.T.U.....	112.7	117.4	119.5	118.6	119.0	120.0	122.4
Producer efficiency ...	0.578	0.488	0.514	0.566	0.657	0.534	0.522
Coal per B.H.P. per hr., lbs.....	2.28	2.48	2.61	2.13	1.83	2.42	2.13
Coking.....	None	None	None	None	None	None	Very slight
Average interval between poking....	5 hours	6 hours	2¼ hours	5 hours	12 hours	2¼ hours	1¾ hours
Clinker.....	Very slight	None	None	Slight	Slight	Slight	None
Tar.....	None	Gas washer not used; no tar	None	None	None	Very little from scrubber	None
Uniformity in gas quality.....	Very uniform	Very uniform	Very uniform	Fairly uniform	Fairly uniform	Very uniform	Fairly uniform
Amount of steam used.	Very little	None	None	None	Very little	Small amt.	Small amt.
Combustible in refuse.	Not analysed	Moderate	Moderate	Not analysed	Little combustible	Rather rich in combustible	Little combustible
Remarks.....	Very suitable fuel for producer; easy to work	Very suitable for producer; easy to work	Easily worked, very suitable for producer	Easily worked, very suitable for producer	Very easy to work in producer	Very little trouble; easy to work	Good for producer work; very little trouble.

Test Under Commercial Conditions.—In view of the good results obtained with these fuels and the fact that a few bags of Nos. 40, 42, 43, 44, and 46 were left, it was decided to mix these and to run the plant 10 hours a day until they were used up, banking the fire at night, as would be done in a commercial installation. Trial 16 was run under these conditions and lasted three days (28 hours running time, 28½ hours with fire banked). Part of the refuse removed during the day runs was used for banking, together with 200 pounds of fresh fuel. The gas was not washed during the test, the sawdust scrubber was not used, nor was any steam supplied to the fuel. No difficulty was experienced from tar or clinker, the fire required very little attention, and gas for starting was easily obtained after standing during the night.

The leading particulars of this trial (No. 16) which was made with a mixture of lignites, Nos. 40, 42, 43, 44, and 46 ; 28 hours running, 28½ hours banked, are :

Composition of Coal.—Fixed carbon, 40.8 ; volatile matter, 31.1 ; ash, 9.6 ; moisture, 18.6 per cent.

Calorific Value as Charged.—8,900 B.T.U. per pound.

Gas.—Calorific value (lower) 122.2 B.T.U. per cu. ft. at 60° and 14.7 lbs. per sq. in.

Steam.—No steam supplied.

Weights of Coal Used.—

Total coal charged during running time..... 2365 lbs.
" " used for banking..... 200 lbs.
" " " " re-starting ..... 350 lbs.
Average B.H.P. during running time..... 30.3

	Running time only	Including coal used for banking and re-starting
Coal charged per B.H.P. per hr.....	2.79 lbs.	3.44 lbs.
Efficiency of producer and gas cleaning apparatus.....	0.495	0.401

Remarks.—Fuel very suitable for use in a producer of the down draft type, without the supply of any steam.

All the fuels tried in this group proved easy to work and gave good results. No. 46 showed the best efficiency. They appear much more suitable for use in a properly designed gas producer than in an ordinary steam boiler. The fuel bed analysis indicates that somewhat too much fuel was charged in the case of Nos. 42 and 2040 (trial 17), while in coal No. 44 the bed was poor in combustion ; the apparent efficiency given is, therefore, probably too low for No. 42 and (trial 17) No. 2040, and slightly too high for No. 44.

Heat Expenditure with Various Coals.—In the accompanying table the fuels tested have been arranged in order of the heat value of the amount of coal charged per B.H.P. per hour. This table gives the proportional cost for fuel, assuming that all the coals were sold at the same price per thousand B.T.U This order of arrangement is not quite fair to some coals, and gives others some slight advantage, but affords a general idea of the relative performance of the various groups.

HEAT VALUE OF COAL CHARGED PER B.H.P. PER HOUR

(Coals Arranged in Order of Apparent Economy)

Coal No.	Trial No.	Description of Coal	B.H.P. B.T.U. per hr.
46	11	Lignite, Strathcona Coal Co., Edmonton, Alta.....	16490
2040	8	Lignite, Western Dominion Collieries, Ltd., Taylorton, Sask.....	18924
26	40	Coal, Crowsnest Pass Coal Co., Fernie, B.C.....	20460
45	10	Lignite, Standard Coal Co., Edmonton, Alta.....	20470
27 and 30	42	Coal, Crowsnest Pass Coal Co., Fernie and Michel, B.C.	20780
11	29	Coal, King's Mine, Minto, N.B.	21497
22M	25	Coal, Nicola Valley Coal Co., Coutlee, B.C.....	22200
3	23	Coal, Intercolonial Coal Co., Westville, N.S.....	22493
25	38	Coal, H. W. McNeil Co., Ltd., Canmore, Alta.....	22566
23M	41	Coal, Bankhead Mines, Ltd., Bankhead, Alta.....	23000
44	13	Lignitic coal, Alberta Ry. & I. Co., Ltd., Lethbridge, Alta.....	23000
12	30	Coal, Nova Scotia S. & C. Co., Sydney Mines, N.S...	23200
42	15	Lignite, Parkdale Coal Co., Ltd., Edmonton, Alta...	23330
43	12	Lignite, Canadian West Coal Co., Ltd., Taber, Alta.	23350
2	24	Coal, Acadia Coal Co., Ltd., Stellarton, N.S.....	23650
18	20	Coal, Western Fuel Co., Nanaimo, B.C.....	23760
10	27	Coal, Canada Coal & Ry. Co., Ltd., Joggins, N.S....	23840
34	36	Coal, International Coal & Coke Co., Coleman, Alta.	24800
5	22	Coal, Cumberland Ry. & Coal Co., Springhill, N.S..	27160
29	35	Coal, Crowsnest Pass Coal Co., Fernie, B.C.....	29730
35	31	Coal, Dominion Coal Co., Ltd., Glace Bay, N.S....	30500
37	33	Coal, Dominion Coal Co., Ltd., Glace Bay, N.S....	30690
17	19	Coal, Western Fuel Co., Nanaimo, B.C.....	30790
8	26	Coal, Acadia Coal Co., Ltd., Westville, N.S.....	31010
15	21	Coal, Richmond Ry. & Coal Co., Port Hood, N.S...	31703
36	32	Coal, Dominion Coal Co., Ltd., Glace Bay, N.S....	32450
48	14	Coal, Leitch Collieries, Ltd., Passburg, Alta.....	33210
38	34	Coal, Dominion Coal Co., Ltd., Glace Bay, N.S....	36030

Perhaps the most striking result of the series of tests is the excellent performance of the lignites. This is brought out well in the foregoing table. The Crowsnest coals and Alberta anthracites also gave good results. The lower places in the table are taken (generally speaking) by coals whose caking qualities render them difficult to handle in a gas producer of small size.

Domestic Fuel Problem

The domestic bituminous coal used in the West comes largely from the United States and Western Alberta. Lignite and semi-

bituminous coal is mined in the Souris district, Saskatchewan, and in the Edmonton and Lethbridge districts, Alberta. This coal is used generally to supply local demand and the nearer markets. Owing to the nature of the coal, considerable slack is made, and, as it does not pay the operator to ship this, it is wasted.

Sources of Supply

The dependence of these provinces upon the supply of Crowsnest coal may be more fully realized from the fact that several coal famines have resulted from coal strikes in the Crowsnest and Banff districts. The territory east of Brandon is largely supplied by United States coal, and no provision has yet been made for a store of fuel to tide the country over a possible stoppage of supply. It is, therefore, of great importance that something be done with a view to utilizing the low-grade fuels which underlie the greater portion of Alberta and part of Saskatchewan and Manitoba.

In order to make the coal transportable and suitable for domestic use, it would be necessary :

1. That it be of sufficient value to be able to bear the cost of transportation.
2. That it withstand handling and a certain amount of weathering.
3. That it be a suitable fuel for domestic and power purposes.

Utilizing Low-grade Fuels—Briquettes

Coal briquettes fulfill these conditions, and it is desirable that investigations be carried on with a view to determining the suitability of the lignite and low-grade coals for the manufacture of briquettes.

In the case of bituminous and anthracite coal, it is possible to manufacture briquettes on a commercial basis, only where supplies of pitch binder can be conveniently had. In the case of lignites, the percentage of pitch binder required is less, and the United States Bureau of Mines has demonstrated that they can even be briquetted without the use of a binder. The magnitude of the briquetting industry in Germany and the part it plays in utilizing the lignite or brown-coal deposits of that country are shown by the fact that, in 1910, the German Empire produced 21,575,000 short tons of briquettes, of which 16,675,000 tons—77 per cent of the total—were made from lignite.

Mr. C. L. Wright in *Bulletin No. 14*, p. 10, of the United States Bureau of Mines, says :

Enough testing has been done to indicate that some American lignites equal German lignites in fuel value and can probably be made into briquettes on a commercial scale without the use of binding

materials. Three samples of lignite, one from Texas, one from North Dakota, and one from California were made into satisfactory briquettes without the addition of a binder. It was proved that some lignites after having slacked by exposure, can be made into briquettes without the use of binding material, notwithstanding a general opinion that this could not be done. Cohesion and weathering tests demonstrated that good briquettes endure handling and resist weathering much better than the lignite from which they are made.

As the coal-fields of the Prairie Provinces are situated at a great distance from the nearest place where mine-timbers can be obtained, the cost of the timber is a large item of expense. On this account, a minimum amount of timber is used in the mines, and less coal is therefore recovered than would be the case if the cost of timber were not so prohibitive. The average recovery of marketable coal is about 50 per cent from the lignite mines ; and ten per cent of the coal mined is wasted on the surface.

The Problem Stated

The coal is low-grade, and, upon exposure to the air for a short time, loses its moisture and disintegrates. This prohibits shipping for a great distance. Furthermore, if it is left piled on the surface for a short time, it is liable to ignite from spontaneous combustion. To overcome these difficulties, it is necessary, not only to increase its selling value, but also to put it in some form which will render shipment to the domestic markets possible. If the economic side of the problem were ignored, the desired result could be secured by generating electric power from lignite fired in boilers, or from producer gas generated at the mine. The electricity thus generated could be transmitted wherever it was needed for power and lighting purposes The problem could also be solved by making lignite briquettes for domestic fuel and for power purposes.

The lignite in this field is low in heating value, some of it containing about 28 per cent by weight, of moisture, and it is therefore difficult to burn in furnaces designed for the better grades of coal. The tests* made on North Dakota lignite by the United States Bureau of Mines, however, have shown the possibility of designing suitable furnaces for burning a similar lignite profitably.

**North Dakota Lignite as a Fuel for Power Plant Boilers.* Bull. 2, U.S. Bureau of Mines.

The economic results of these tests are given below :

TESTS OF NORTH DAKOTA LIGNITES

Test No.	Equivalent evaporation from and at 212° F., per lb. of fuel: As fired	Dry	(c)	Apparent evaporation per lb. of coal as fired	H. P. developed: In boiler	p.c. of rated	Efficiency (per cent) (e) of boiler and furnace: Alone	Incl. grate	Over all
1...	3.50	....	....	2.90	202.6	81.0	....	.....	.....
2...	3.69	6.33	7.35	3.07	238.7	95.5	61.35	60.39	.....
3...	3.43	6.01	7.07	2.84	275.2	110.1	58.99	57.47	.....
4...	3.36	6.02	7.34	2.79	184.7	73.9	61.23	57.70	52.59
5...	3.79	6.28	7.14	3.16	215.8	86.3	59.38	58.33	53.59
6...	3.30	5.65	6.72	2.77	243.4	97.4	56.05	54.42	49.98
7...	3.63	6.27	7.34	3.03	224.8	90.0	61.46	60.94	55.52
8...	3.16	5.62	6.68	2.61	256.1	102.4	55.56	53 65	49.81
9...	3.46	6.23	7.22	2.88	220.7	88.3	60.17	59.04	53.70
10...	3.77	6.70	7.72	3.11	208.7	83.5	64.24	63.30	57.88
11...	3.48	6.10	7.48	2.86	281.9	112.8	62.52	59.21	54.46
12...	3.58	6.22	7.09	2.96	283.3	113.3	59.10	58.86	54.04
13...	3.67	6.31	7.27	3.07	238.0	95.2	60.47	59.52	54.36
14...	3.77	6.54	7.38	3.11	240.0	96.0	61.33	61.14	55.82
15...	3.03	5.28	6.15	2.50	229.3	91.7	51.24	49.64	.....
15A..	3.34	5.83	6.80	2.75	258.2	103.3	56.66	54.81	.....

(c) Moisture and ash free.
(e) Figured from chemical analyses of ash and coal.

On exposure to the air lignite slacks or crumbles. The lumps check and fall into small irregular pieces that exhibit a decided tendency to separate into extremely thin plates. Hence, it deteriorates greatly during storage or long transportation. The most characteristic feature of the composition of lignite is the large percentage of moisture it contains. When freshly mined, this high moisture content reduces the fuel value, and the partial evaporation of moisture on exposure, causes it to check and fall to pieces. Consequently, attempts to increase the efficiency of lignite as a fuel involve the reduction of its moisture and the increase of its ability to endure storage and transportation. Both these results are accomplished by briquetting.

The problem of a fuel supply in the Canadian prairies is of peculiar interest, as many of the lignite deposits are situated long distances from fields of high-grade coal. The problem assumes still larger proportions when one realizes that the development of manufacturing industries in these regions depends upon the ability to obtain a cheap and satisfactory fuel. Owing to the importance of obtaining a suitable domestic fuel for the Prairie Provinces, and to the fact that these provinces have been estimated to contain over 100,000,000,000 tons of sub-bituminous and lignite coal, or about 60 per cent of the total coal in Canada, it is necessary that investigations should be carried on with

the object of demonstrating whether briquettes and producer gas can or can not, be made from this coal.

Experience of Foreign Countries

Europe.—For many years European countries have been developing supplies of fuels that have low heat values, and they have succeeded in making the utilization of peat, lignite, and the screenings of bituminous coal and anthracite the basis of important industries. In several countries, large amounts of capital have been invested in the manufacture of fuel briquettes. The magnitude of the briquetting industry in Germany, and the part it plays in utilizing the lignite or brown-coal deposits in that country, are shown by the fact, that, in 1910, the German Empire produced 21,575,000 tons of briquettes, of which 16,675,000 tons, or 77 per cent of the total output, were made from lignite. For domestic use, these lignite briquettes are very popular and form the chief household fuel in many large cities.

United States.—The United States Bureau of Mines has lately issued a report* on briquetting tests of lignite, which is of considerable significance to Canada, inasmuch as some of these tests were made on North Dakota lignite. The lignite of the Souris valley is the northward continuation of the North Dakota lignite field. The tests were undertaken to ascertain the following :

1. The possibility of briquetting American lignites without adding binder to them.
2. The suitability of the German brown-coal briquette presses for briquetting American lignites.
3. The percentage of moisture needed in the raw material to give the best briquettes.
4. The approximate commercial cost of briquetting lignites.
5. The weathering qualities of briquettes as compared with raw lignites.

The following conclusions were drawn from the results of the briquetting and extraction tests :

1. Lignites containing less than 1.4 per cent of matter soluble in carbon bisulphide (calculated to a moisture-free basis) have not been briquetted with the German machine, nor with any other machine, without the addition of a binder.

2. Lignites containing 1.4 to 1.5 per cent of matter soluble in carbon bisulphide are difficult to briquette, and further tests are needed to determine whether entirely satisfactory briquettes can be made from them with the German machine.

*Briquetting Tests of Lignite. Bull. 14, U. S. Bureau of Mines.

3. The few lignites tested that contained more than 1.5 per cent of matter soluble in carbon bisulphide were briquetted with the German machine without binder.

4. The percentage of moisture that dried lignite must contain to give satisfactory briquettes with the German machine is, within limits, proportional to the percentage of matter soluble in carbon bisulphide. Hence, if two lignites have the same ash content, the one that is richer in bitumen may be dried more and will give briquettes of higher value (because of the lower moisture content) than the other.

Briquetting the lignite will improve its heat value 30 to 40 per cent by reducing the percentage of moisture. Moreover, the briquettes have the following additional advantage over raw fuel :

(*a*) Being of uniform size, they burn more freely and give off less smoke, a decided merit when used as a household fuel in a residential district.

(*b*) The briquettes resist the effects of the weather much better than the raw fuel, and therefore can be stored for a longer time without serious deterioration. The briquettes are not, however, much more waterproof than the raw fuel, and should be stored under cover ; there they will remain in perfect condition for several months at least, while the raw fuel, under similar conditions, will disintegrate rapidly.

(*c*) The cost of transporting the briquetted fuel should be only 80 per cent of the cost of transporting enough raw fuel to furnish the same heat value.

Preliminary results from gas-producer tests of raw and briquetted samples of this lignite (California lignite) showed that the consumption of fuel, as fired per hour per brake horse-power developed, was 4.06 pounds for the raw lignite, and only 2.84 pounds for the briquettes.

Cost of Briquettes.—The tests described indicate that the cost of briquetting run-of-mine lignites with a German plant would be from $1.35 to $1.75 per ton, according to the location of the plant.

On the assumption that the plant cost $56,000 ; that it is to be located at the mine ; is to be run two shifts of ten hours each, or 20 hours per day ; and is to have a capacity of 50 tons of briquettes per day of 20 hours, the costs would figure out as follows :

Cost of one ton of lignite at the mine: in California, $2.46; in Texas, $0.90 ; and in North Dakota, $1.45.

Total cost of briquetting one ton of briquettes; in California, $1.72; in Texas, 1.33; and in North Dakota, $1.46.

The cost per ton of briquettes loaded on cars, from a briquette plant at the mine would be : in California, $5.24 ; in Texas, $2.51 ; and in North Dakota, $3.53.

The cost per long ton of briquetting lignite in Germany varies from $1.14 to $1.86, depending upon the size of the plant, moisture content, and conditions of mining.

The report states that :

Although the results obtained in this bulletin are not conclusive they warrant the continuation of the investigations as soon as funds can be made available for that purpose. Enough testing has been done to indicate that some American lignites equal German lignites in fuel value, and can probably be made into briquettes on a commercial scale, without the use of binding materials. Three samples of lignite, one from Texas, one from North Dakota, and one from California, were made into satisfactory briquettes without the addition of a binder. It was proved that some lignites after having slacked by exposure can be made into briquettes without the use of binding material, notwithstanding a general opinion that this could not be done. Cohesion and weathering tests demonstrated that good briquettes endure handling and resist weathering much better than the lignite from which they are made.

Utilization of Slack in the Crowsnest District

The slack made in coal-mining operations in the Crowsnest Pass district is usually coked in beehive ovens, but there is only a limited market for the coke, and the freight rates make it impossible to market the slack coal to advantage. There are a number of seams of coal (often upper seams) which, at the present time, cannot be worked on account of the large percentage of slack made during mining, but which could be worked to advantage if there was a ready market for the slack.

The coke sold is used for smelting purposes in British Columbia. The smelters in the neighbouring Western States also afford a natural market for the coke, but it is understood that few or no contracts are made with them as they are unable to depend upon the mines for a constant supply. The explanation of this is that labour conditions are not so settled in the Crowsnest field as in the American bituminous coal-fields.

Supply of Binder—The solution to the problem of the economic disposal of slack coal would be brought about by the manufacture of briquettes, but this industry cannot become possible until a sufficient supply of binder is available. Several binders have been used in the manufacture of coal briquettes, but the most desirable kind, and the one most widely used, is tar pitch. This pitch is a by-product from coal-tar recovered from by-product coke ovens. In California,

Arizona, and other parts of the West, asphaltic pitch, the residual product from the refining of the heavy asphalt-base petroleums of that region, has been, and is now, successfully used in briquetting plants. There are enormous deposits of tar-sands on the Athabaska river, and on the development of these there will be made available an enormous supply of pitch suitable for briquetting purposes. For the present, however, coal-tar pitch may be considered as the base for a briquetting industry.

Coking of Coal

The coke produced in the West is used almost entirely for metallurgical purposes. In other countries, coke also affords a good substitute for bituminous and anthracite coal. As a domestic fuel, and for all ordinary industrial purposes, such as baking, drying, heating and steam raising, it is fully equal to anthracite coal ; it lights quicker and holds the heat as well, while its smokelessness renders it easily superior to bituminous coal. It requires no special appliances to burn it, and only a slightly different adjustment of draughts. The extent to which it is used in the United States is shown by the fact that in Everett, Mass., one plant alone supplies about 200,000 tons per year for domestic and industrial service, and a similar amount is used for firing locomotives, particularly in suburban service, because of its smokeless nature.

A Potential Market.—The accompanying map shows that United States anthracite coal is used as far west as Battleford. The cost of this coal varies from $10.50 a ton at Winnipeg to $15.00 at Battleford. As the average value of one ton of coke in Western Canada is $4.50, and as the freight rate on one ton of coal from Fernie to Winnipeg is $4.70, it can be seen that if the use of coke can be brought to the attention of the public by proper methods, most of this area now supplied by United States anthracite could be supplied more cheaply by Canadian coke.

Use of By-product Ovens

Canada and the United States are far behind Germany and other foreign countries in adopting the economies resulting from the coking of coal in by-product ovens. In Germany, at the present time, little or no coke is made except in retort (by-product) ovens. When the economies which may be effected by the use of such ovens have been so clearly demonstrated, not only by plants which have been constructed in Europe, but also by plants in the United States and at Sydney and Sault Ste. Marie in Canada, it seems difficult to understand why they are not more generally adopted in Western Canada.

There are several reasons why they have not been introduced ; first, the greater cost incurred in installing them, and second, the lack of markets for the resultant by-products.

Economies Effected.—The following are some of the economies which may be effected by the use of by-product coke ovens as against the use of beehive ovens :—

1. The quality of the coke is just as good for metallurgical purposes as coke made in beehive ovens.

2. The yield of coke from by-product ovens is from 10 to 15 per cent higher than the yield from bee-hive ovens.

3. While the cost of installation per oven is greater for the by-product than for the beehive oven, the capacity is from three to six times as great.

4. In by-product ovens, the following by-products are saved :

1. *Gas.* With an ordinary coking coal, this amounts to about 5,000 cubic feet per ton at 500 B.T.U. per cubic foot. This gas can be used for firing under boilers, running gas engines, illuminating purposes or for any other purpose for which coal gas may be employed. If it is used in gas engines, about 250 horse-power-hours can be obtained from the surplus gas from one ton of coal.

2. *Ammonia.* About 20 lbs. of ammonium sulphate to the ton of coal charged is obtained. This is worth about $71 per ton. The ammonia may be recovered as ammonium sulphate for fertilizer, or, as a concentrated liquor for refrigeration purposes.

3. *Tar.* This amounts to from 7 to 9 gals. per ton of coal charged and is worth from 2 to 3 cents per gallon in the crude state. It is worth far more if distilled—creosote, light oils, carbolic acid and pitch being recovered. The pitch is valuable as a binder in the manufacture of coal briquettes.

The total value of by-products saved per ton of coal charged into an oven is as follows :

Higher yield of coke—10 to 15 per cent—at $4.50 per ton*	$0.45 to $0.67½
Gas—5,000 cu. ft. at 10c. per M	.50
Ammonium sulphate—20 lbs. at $71 per ton	.71
Tar—7 to 9 gals. at 2c. per gal	.14 to .18
Total	$1.80 to $2.06½

*Average value of beehive-oven coke in Western Canada.

The following is a general comparison of beehive and by-product ovens *:

BEEHIVE OVEN

Ordinary type, 12.5 ft. in diameter.

Cost from $700 to $1,200 per oven.

Produces 4 net tons of coke in 48 hrs. = 2 net tons in 24 hrs.

Yield of coke from coal, 60 per cent.

By-products and surplus gas—none.

BY-PRODUCT OVEN

[In this comparison Mr. Lucas does not give statistics of cost of by-product ovens, but, as quoted below, estimates the cost of a 100-oven plant at $1,000,000 or $10,000 per oven. Enquiries addressed to manufacturers of these ovens failed to elicit any definite statement of cost.]

Oven charge, 9 tons.

(Ovens may be larger or smaller than this, but 9 tons would be about the average charge for the modern type of oven.)

Coking-time, 24 hrs.

Coke produced on 70 per cent yield = 6.3 tons per oven in 24 hrs.

By-Products.—

Ammonium Sulphate. 22 lbs. per net ton of coal = 31 lbs. per net ton of coke. Value, 2.25c. per lb. above cost of manufacture = 70c. per ton of coke made.

Tar. 8.5 gals. per ton of coal = 10.7 gals. per ton of coke. Value at 2c. per gal. = 21c. per ton of coke.

Surplus Gas. 5,000 cu. ft. per ton of coal = 7,143 cu. ft. per ton of coke. Value at 10c. per 1,000 cu. ft. = 71 cents per ton of coke.

Total Value of By-products as Above

Ammonium sulphate	$0.70
Tar	0.21
Gas	0.71
Value per ton of coke	$1.62

Assuming coal to be worth $1.50 a ton, add to the foregoing the difference between 60 per cent yield in beehive ovens and 70 per cent in by-product ovens on the same coal—

Coal per ton of coke produced in beehive oven	$2.50
Coal per ton of coke produced in by-product oven	2.14
Balance in favour of by-product oven	$0.36

**The Manufacture of Coke.* By F. E. Lucas. Bulletin of the American Institute of Mining Engineers. No. 71, p. 1324.

So that the total saving in coal and by-products equals $1.62 + $0.36 = $1.98 per ton of coke made, = $12.47 per oven in 24 hrs. = $4,551.55 per oven per year ; or for by-products alone, without counting the saving in coal, $3,723 per oven per year.

For a plant of 100 ovens, the saving = $455,155 per year. Cost of 100-oven plant complete, approximately $1,000,000. A 100-oven plant of the above-mentioned capacity will produce 630 tons of coke per day = 229,950 tons per year, working on 24 hrs. coking time.

If benzol is recovered, it will further add to the income from by-products.

Markets for By-products

Gas.—The gas can be used to furnish power for mining purposes. Where there is a market near at hand, the most profitable use for the gas is for illuminating and domestic purposes. As stated before, one ton of coal will furnish about 5,000 cu. ft. of gas over and above that required for heating the ovens and coking the coal. The gas has a thermal value of from 500 to 550 B.T.U. per cubic foot. In gas-engine practice, about 25 cu. ft. of such gas will develop one brake horse-power hour. When burnt under boilers in connection with reciprocating steam engines, about three times this amount of gas will be required to develop one brake horse-power.

Ammonia.—The ammonia may be recovered as ammonium sulphate, or concentrated crude ammonia containing from 14 to 18 per cent NH_3. In the latter instance, it can be disposed of to manufacturers of alkali, soap and chemicals of various kinds. In the form of ammonium sulphate, it is used chiefly as a fertilizer, containing approximately 20 per cent of nitrogen, a most valuable fertilizing element.

The market for ammonium sulphate is practically unlimited, and, in the near future, enormous quantities will be required to maintain the fertility of the soils of the Prairie Provinces. These soils were formed by sedimentation from large glacial lakes and are composed of granitic-rock particles containing the potassium and phosphorus which were accessory constituents of the granite. Some of this material has been weathered and made suitable for agriculture by the action of the ice, glacial rivers and the atmosphere. The soil having been exposed to the action of the weather for ages, plant life has grown on it, died, decayed and, in this process, has fertilized the land. At the present time, crops are being taken off the land and no fertilizer is added to replenish it. As a consequence, the thin fertile layer of surface soil is already becoming exhausted.

The extent to which the depletion of the fertilizing elements has gone on may be approximated from the information obtained by an

agricultural survey of representative farms in these provinces conducted by the Commission of Conservation. In this survey, information was obtained concerning the present crop yield of the Prairie Provinces as compared with those of ten and twenty years ago. In Manitoba 56 per cent of the farmers visited reported an average decrease of 12 per cent in yield as compared with ten years ago, and 9 per cent reported a 24 per cent decrease as compared with twenty years ago. Only two farmers of the 100 visited reported any increase in yield, and practically all said they were not now getting the yield they should nor what they formerly did. In Saskatchewan, 42 per cent of the farmers visited reported an average decrease of 7 per cent in yield as compared with ten years ago. In Alberta, 16 per cent reported an average decrease of 25 per cent in yield as compared with ten years ago. In some districts, where crops have been grown for only ten years, a decrease in crop yields is quite noticeable.

The rapidity with which the fertility of the soil is being exhausted by the present single-cropping system shows that by-product coke oven plants will eventually have an enormous market for the ammonium sulphate they produce.

Tar.—The yield of tar varies a good deal, according to the quality of the coal and the efficiency of the cooling-apparatus, but may be considered as from 7 to 9 gals, or about 77 to 100 lbs. per ton of coal.

It may be worked up into various marketable products. A great deal of it is used as a coating for pipes, castings and all kinds of iron work, and in the manufacture of water-proof paint. Felt is saturated with it to make various forms of prepared roofing and water-proofing. On distillation, it forms pitch and light and heavy oils. The pitch is used for paving, water-proofing, and as a binder for the manufacture of coal briquettes. The amount of pitch recovered in this way from one ton of coal, varies from 51 to 67 lbs. In other words, the pitch recovered from one ton of coal is sufficient to briquette one-half ton of coal briquettes.

In 1910, Canada produced about 367,285 tons of beehive coke* from beehive ovens, valued at $1,658,987, from 575,582 tons of coal. Consequently, there was enough pitch wasted to briquette 287,000 tons of coal. This waste has occurred regardless of the fact that over 15 per cent of the output of many of the mines has been wasted as slack coal. It can be seen from this that there is an unlimited market for pitch as a binder in the manufacture of briquettes in the locality where the tar would be produced.

*The figures for 1911 are not given, as the coke ovens were closed down for a portion of the year on account of a coal strike.

Creosote.—In the distillation of 77 to 100 lbs. of tar (the tar recovered from one ton of coal), about 17 to 22 lbs. of creosote oils are obtained. This is equivalent to from 1.6 to 2.1 gals. Creosote is used as a preservative of wood, and in the manufacture of chemicals.

Wood Preservative Treatment

By far the largest part of the oils distilled from coal-tar in Europe is employed for preserving railway ties, telegraph poles, and piles used for harbour piers. In the West, there is an almost unlimited market for creosote for preserving mine timbers and railway ties.

Railway Ties.— With regard to railway ties, the following, quoted from *Bulletin No.* 35, Forestry Branch, Department of the Interior, is of interest :—

In Canada during 1911 only 206,209 ties received preservative treatment, or about 1.5 per cent. of the total number purchased. This is nevertheless an indication of the growing interest taken in the subject by tie-users. In 1910 practically no treated ties were used, but since that time two plants have been established and are now treating ties for some of the larger railway companies.

An estimate of the saving that could be accomplished by a more universal use of treated material is of great interest. The average life of an untreated tie is seven years, and with the increasing use of perishable woods like jack pine, hemlock and spruce, this figure will be greatly reduced in time.

Assuming that there are about 70,000,000 ties placed in roadbeds on well established lines in Canada, and that one-seventh of these are replaced each year, one can safely estimate the annual replacements at 10,000,000. The average life of a treated tie is seventeen years, and if the ties in use in Canada were treated the annual replacements would be one-seventeenth of the 70,000,000, or only a little over 4,000,000. To make this estimate conservative we can call the saving 5,000,000 ties a year. The average tie is cut from a log containing 70 feet, board measure, of material, so the result would be an annual saving to the country of at least 350,000,000 feet, board measure, of raw material every year.

The saving in dollars and cents to the tie purchasers is also worth considering. The average tie purchased in 1911 cost 38 cents at the point of purchase, and 20 cents to put in place ; this brings the initial cost to 58 cents. In an untreated state this tie would last 7 years, and if the initial cost is divided by the number of years' service and a rate of interest of 5 per cent on the investment allowed, the annual cost of such a tie is found. This would amount to a trifle over

10 cents a year. If the same tie were treated with creosote at a cost of 35 cents, it would last seventeen years. Its initial cost would be 93 cents, and its annual cost through its lifetime only about 8 cents. This would result in a saving of two cents per tie per annum, and, applied to the 70,000,000 ties in use, would amount to a saving of $1,400,000 annually.

In considering the advisability of applying preservative treatment to railway ties, the question of mechanical wear cannot be neglected. In the case of the softer woods it frequently occurs that the tie is actually worn out long before it decays. The constant sawing and cutting of the rail and the pulling and redriving of the spikes cannot be prevented by preservative treatment. A thorough impregnation with creosote reduces the moisture content in the tie and prevents further absorption of moisture. The result of this is an actual increase in the strength of the tie, but its amount can hardly be measured.

If, however, tie plates are used to prevent this excessive mechanical wear and if preservative treatment is applied to prevent decay, the average life of the tie can be greatly increased. In addition to this, inferior species can be used for ties at a further saving. Jack pine, spruce, hemlock, lodgepole pine, Western yellow pine and many other species cannot be used economically for ties at present on account of rapid decay or mechanical wear, but were they treated and protected they would make excellent tie material.

Mine Timbers.—With regard to preservative treatment for mine timbers, the following is quoted from *Bulletin No.* 107, Forest Service, U. S. Dept. of Agriculture :

The results of the investigations discussed in this bulletin may be summarized as follows :

1. Decay is, in general, the agency most destructive to timber used in mines.

2. Although decay may often be retarded by peeling and seasoning, treatment with a suitable preservative is more effective.

3. The average life of green, unpeeled, and untreated loblolly-pine gangway sets, under the conditions of the experiments discussed, was less than one and one-half years. Brush treatments with creosote and carbolineum increased this to three and four years, while impregnation treatments with zinc chloride and creosote left from 70 to 90 per cent of the timbers sound at the end of four years.

4. The use of treated timber results in a saving in the cost of maintenance of workings and a reduction in the amount of timber

required and makes possible the utilization of inferior species of wood.

5. Brush treatments are economical when the amount of timber to be treated will not warrant the erection of a small open-tank or pressure plant, or when only a short increase in service is required.

6. The open-tank process is adapted to the treatment of small quantities of easily impregnated timber. When a large amount of material is to be treated, a pressure process should be used.

7. Mine timbers impregnated with zinc chloride and creosote oils have shown the best results. Up to the present, no difference in their durability has been noted.

8. An efficient system of inspection and careful supervision in the use of timber will reduce waste and result in considerable economy. Necessary waste can in many cases be utilized.

APPENDICES

Explanatory

Information with respect to the Coal Mines of Western Canada, given in Appendix I. was collected and compiled during 1911, while that for Nova Scotia was prepared in 1912. In so far as possible, however, this information has been brought up to date.—*Editor*.


Commission of Conservation
Canada
HONOURABLE CLIFFORD SIFTON CHAIRMAN
JAMES WHITE ASSISTANT TO CHAIRMAN
COAL CONSUMPTION
OF
RAILWAYS IN CANADA
Scale 100 miles to one inch
Jasper Park coal
Vancouver Island coal
Nicola Valley coal
Canmore and Lethbridge coal
Drumheller and Dunkirk coal
Grand Forks coal
Crow's Nest coal
Nova Scotia coal
Old Standard locomotives
Electric locomotives
Note 1 Although that portion of the C.N.R. so coloured
green Vancouver Island coal is now being used
but oil burning locomotives will be installed
shortly.
Note 2 The C.P.R. uses Jasper Park coal
on the line from Donnan west
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
NEW BRUNSWICK
NOVA SCOTIA
PRINCE EDWARD ISLAND
James Bay
LAKE SUPERIOR
LAKE MICHIGAN
LAKE ERIE
LAKE ONTARIO
ATLANTIC OCEAN
NORTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
NEW YORK
VERMONT
MAINE

APPENDIX I

COAL MINES OF NOVA SCOTIA

INTRODUCTION

DURING the earlier history of coal mining in Nova Scotia considerable waste occurred in the mining and utilization of coal, but, at the present time, owing to the great demand for coal for domestic use, power and smelting, the larger producers have, as a matter of business, incurred heavy expenditures to effect the maximum economy.

These economies may be considered in connection with the following operations :

1. Mining
2. Utilization of Coal

Mining

Under this head, it is necessary, first, to consider how the coal lands are disposed of ; also, the provisions (direct or indirect) with regard to methods of mining employed.

Disposal of Coal Lands.—The coal lands are disposed of under a leasehold system, the term of the lease being twenty years (except in special cases), with the option of three renewals, making a term of eighty years in all. Under these conditions, there is little incentive to fevered haste to rob and ruin valuable coal-seams, and more care is exercised in gaining a thorough knowledge of the conditions of occurrence of the coal, before the method of extraction is adopted. The long period lease also gives confidence to capital and permits larger expenditures, that the waste in the mining and utilization of the coal may be reduced to a minimum.

Other advantages of a leasehold system are :

1. The government obtains a revenue from every ton of coal produced.

2. The government retains the title to the coal area which would not be the case if disposed of in fee simple.

3. There is less likelihood of conflict between owners of surface rights and owners of coal rights.

4. Private interests cannot hold coal lands for speculative purposes.

5. The government has the power to insert in the leases, clauses that will prevent wasteful mining operations, and also to require the operators to give complete information relating to the work.

The method of mining to be adopted in the different localities is generally understood, and, before a mine can be developed or a new section of a mine opened up, it is necessary that the plans be approved by the Department of Mines. In addition, the Government requires all operators to make yearly returns showing the extraction obtained, etc. The following is a reproduction of the "Coal Depletion Statement" issued by the Nova Scotia Department of Mines :

COAL DEPLETION STATEMENT

.....Company.....Year.....

.....

ITEMS	QUANTITY
Average thickness of coal seam in feet.....	
Angle of dip.....	
Area worked over during year.....	
Total quantity, by calculation in tons, in area worked over during year....	
Quantity extracted in tons from area worked over during year.....	
Percentage of quantity extracted from area worked over during year.....	
Quantity in tons, remaining in area worked over during year.....	
Quantity, in tons, recoverable from area worked over during year.....	
Percentage loss or not recoverable from area worked over during year....	
Total area in acres worked over in the colliery at close of 1906.....	
Total area in acres worked over in the colliery at close of 1910.....	

Name or No. of colliery.....
Name of coal seam.....
System of working.....
Total area proposed to be worked from.....colliery....
Remarks.....

The information thus obtained is not only of value in determining the rate of exhaustion of the coal-fields, but also allows a comparison of the methods adopted, thus tending to standardize the methods employed.

Mining Methods.—As a result of the systematic manner in which mining is carried on in Nova Scotia, large sections of coal have been mined with but very little loss. It is the practice, generally, to mine the highest workable coal seams first and to leave large pillars in advance work to support the weight of the superincumbent strata. Where superimposed seams are worked contemporaneously, the work in the upper seam is kept well in advance of the lower, and pillars are never drawn in the lower seam until all the pillars in that section of the upper seam have been removed and the roof allowed to settle.

Submarine mining is carried on to a considerable extent in Cape Breton, and, with the exception of the flooding of the mine at Port Hood, no accidents have occurred and no coal has been lost. Generally speaking, few submarine pillars have yet been extracted, but the pillars left are of such dimensions that it will be possible, where sufficient cover

exists, to recover them in retreat, after the boundaries of the mines have been reached. Where seams extend seaward beyond the limits of a submarine property, drawing the pillars should be forbidden. If the company's lease does not provide that they be left in place, compensation for the pillar coal could be made.

With regard to size of the pillars and width of rooms in Dominion Coal Co.'s submarine areas below the 180-feet limit, the following dimensions were agreed upon as a standard, in 1904 :

DIMENSIONS OF ROOMS AND PILLARS, DOMINION COAL CO.

Depth of cover (feet)	Harbour Seam		Hub and Phalen Seams		Percentage of Coal Left in Pillars
	Room width (feet)	Size of pillar	Room width (feet)	Size of pillar (feet)	
200	20	27 x 75	20	30 x 75	51
250	20	27 x 75	20	30 x 75	51
300	20	30 x 75	20	34 x 75	54
350	20	33 x 75	20	36 x 75	56
400	20	36 x 75	20	42 x 75	58
450	20	39 x 75	20	46 x 75	60
500	20	42 x 75	20	50 x 75	61
550	20	45 x 75	20	54 x 75	63
600	20	48 x 75	20	58 x 75	64
650	20	51 x 75	20	62 x 75	65
700	20	54 x 75	20	66 x 75	66
750	20	57 x 75	20	70 x 75	67
800	20	60 x 75	20	74 x 75	67
850	20	63 x 75	20	78 x 75	68
900	20	66 x 75	20	82 x 75	69
950	20	69 x 75	20	86 x 75	69
1000	20	72 x 75	20	90 x 75	70

No cross-cut to exceed 12 ft. in width.

The parties to this agreement were P. Neville, John Cadegan, and Neil Nicholson, Government Inspectors ; and Austin King, Supt. of Mines for the Dominion Coal Co. In April, 1907, Messrs. Neville and Mr. Cadegan reported this matter to Dr. Gilpin, Commissioner of Mines, and recommended that no change be made at present, and Dr. Gilpin confirmed the recommendation.

The following table shows the thickness of barrier pillars usually left in the mines operated by the Dominion Coal Company :

WIDTH OF BARRIER PILLARS, DOMINION COAL COMPANY

To be Left on Both Sides of all Deeps, also on Lower Side of Levels where Pillars are to be Drawn Below Them.

Depth of cover (feet)	Harbour Seam*	Hub and Phalen Seams†
	Width of barrier pillar (feet)	Width of barrier pillar (feet)
0	60	90
50	66	100
100	72	108
150	78	118
200	84	126
250	90	136
300	96	144
350	102	154
400	108	162
450	114	172
500	120	180
550	126	190
600	132	198
650	138	208
700	144	216
750	150	226
800	156	234
850	162	244
900	168	252
950	174	262
1000	180	270
1050	186	280
1100	192	288
1150	198	298
1200	204	306
1250	210	316
1300	216	324
1350	222	334
1400	228	343
1450	234	352
1500	240	360

In the Pictou coal field the conditions are not so favourable for the high extraction of coal as in the Cape Breton coal areas. Thus, the great thickness of some of the seams makes it impossible to mine all the seam at one lift ; then high dips quickly increase the depth of cover over the workings, thus making timbering, haulage, pumping and ventilating problems more difficult ; some of them are liable to fires due to spontaneous combustion, and, in several mines, the top bench of the seams was removed a number of years ago. Notwithstanding the above-mentioned disadvantages, the top coal and the bottom coal, which had been previously left in the mine, are now being recovered so far as is economically possible.

* Thickness mined from Harbour seam, 6 ft.
† Thickness mined from Hub and Phalen seams, 9 ft.

Utilization of Coal

Among the economic uses of coal in Nova Scotia may be mentioned :

(1) The generation of power for mining purposes ;

(2) The coking of coal in by-product coke ovens ;

(3) The briquetting of slack coal.

Generation of Power.—Generating electric energy at central power plants and transmitting to surrounding collieries has been developed to such an extent that some of the collieries are now operated entirely by electricity. Electric cables are carried underground by means of bore-holes and the energy is used for mine-haulage and pumping purposes. These plants present many new and up-to-date features such as low-pressure and high-pressure steam turbo-generators and mechanical stokers for firing the boilers with low-grade slack and splint coal.

The Dominion Coal Company has recently installed a power plant at Waterford lake in which Bettington boilers,* fired with pulverized low-grade coal generate steam for the turbo-generators. These boilers are the first of their kind to be installed in America, and will, it is claimed, give a higher efficiency than any other boiler on the market.

Coking of Coal.—Practically all the coke produced in Nova Scotia is made in some type of by-product oven. The Dominion Coal Company recovers gas, tar and ammonia as by-products. The Nova Scotia Steel and Coal Company recovers only the gas, but is considering the erection of by-product ovens. The coking of coal in by-product ovens is important, not only on account of the value of the by-products recovered, but also because the briquetting industry is dependent upon a supply of tar or pitch as a binder.

Much slack coal is now made in mining operations in Nova Scotia, and as the higher grades of coal become less plentiful, lower-grade seams will be worked and more slack obtained. There are, at present, three coal briquetting plants in operation—Inverness Ry. and Coal Co., Inverness, MacKay Mine and Colonial Mine, near Sydney Mines. The Dominion Coal Company also has a briquetting plant under consideration, but has not yet decided where it is to be erected.

Dominion Coal Company

This company is by far the largest coal producer in Canada. In 1912 the output of the Glace Bay Mines was over 4,500,000 long tons, while the production for 1913 will probably be 4,750,000 long tons.

*For description of these boilers see p. 63.

The company controls 125 square miles of coal lands in Cape Breton, of which 75 square miles are held under special 99-year lease from the Government of Nova Scotia, instead of the regular 20-year lease. In return for this concession, they pay the Provincial Government a royalty of 12½ cents per long ton on all coal mined in this area. The remainder—50 square miles—is held under 20-year leases, and is subject to a royalty of 10 cents per ton.

The area held by this company extends from the eastern outcrop of the Morien basin on the east, to the termination of the coal measures at cape Dauphin on the west, and includes the Morien Basin, Glace Bay basin, Lingan-Victoria field, and a portion of the Sydney Mines basin.

F. W. Gray, of the Dominion Coal Company, in a pamphlet on Mining and Transportation, states that :*

> "The following summary of the coal contents of the areas controlled by the Dominion Coal Company was prepared by the late Dr. E. Gilpin in 1902, at which time Dr. Gilpin was Commissioner of Mines for Nova Scotia. No seams under three feet in thickness are included and in making the calculation Dr. Gilpin stated that 'the usual uniformity, regularity and freedom from faults of the strata and coal beds of this district permit of exceptional confidence being placed in any estimate of coal contents.'

SUMMARY

	Tons (2,240 lbs.)
Morien Basin	114,040,000
Glace Bay Basin	527,560,000
Lingan-Victoria Basin	484,160,000
Sydney Mines Basin	309,600,000
	1,435,360,000

Portions of the land and submarine areas of Morien and Glace Bay basins have been developed by the company, but very little coal has yet been mined in the Lingan-Victoria basin and no work at all has been done in the Point Aconi district of the Sydney field.

The following table shows the thickness and equivalency of the known coal seams within the areas above mentioned :

* *Mining and Transportation.* A General Description. By F. W. Gray. Mines Publishing Co., Toronto, 1909.

TABLE I.

COAL SEAMS, SYDNEY COAL-FIELDS

Showing the Equivalency of the Principal Coal Seams in the Sydney Coal Fields with the Intervening Strata in the Several Basins*

Cow Bay Basin. Name of Seam and Thickness	Glace Bay Basin. Name of Seam and Thickness	Lingan. Name of Seam and Thickness
Blockhouse..... 9′ 2″	Hub..... 9′ 8″	Seam A..... 3′ 0″
Strata.....302′ 0″	Strata.....355′ 0″	Strata.....306′ 0″
Seam D..... 1′ 0″	Harbour..... 5′ 8″	Carr seams..... 9′ 10″
Strata.....119′ 0″	Strata.....269′ 0″	Strata.....183′ 0″
Seam E..... 2′ 10″	Bouthillier... 3′ 0″	Barachois..... 10′ 0″
Strata.....139′ 0″	Strata..... 82′ 0″	Strata.....350′ 0″
McAuley..... 6′ 4″	Backpit..... 4′ 5″	David Head.... 7′ 4″
Strata.....202′ 0″	Strata..... 98′ 0″	Strata.....271′ 0″
Spencer..... 4′ 5″	Phelan..... 8′ 5″	Seam D..... 3′ 3″
Strata.....335′ 0″	Strata.....148′ 0″	Strata..... 81′ 0″
Long Beach Seam 2′ 2″	Ross..... 3′ 7″	North Head..... 4′ 0″
	Strata.....393′ 0″	Strata..... 96′ 0″
	Louvey..... 4′ 11″	Lingan Main... 7′ 2″
		Strata.....111′ 0″
		Seam G..... 2′ 4″
		Strata.....252′ 0″
		Seam H..... 1′ 0″

Sydney Mines. Name of Seam and Thickness	Boularderie. Name of Seam and Thickness	Cape Dauphin. Name of Seam and Thickness
Cranberry Head.. 3′ 8″	Point Aconi.. 3′ 2″	Seam D..... 1′ 8″
Strata.....281′ 0″	Strata.....242′ 0″	Strata.....237′ 0″
Lloyd Cove..... 7′ 2″	Bonar..... 6′ 10″	Four feet..... 4′ 0″
Strata.....250′ 0″	Strata.....219′ 0″	Strata..... 53′ 0″
Seam B..... 4′ 2″	Stubbart..... 7′ 6″	Seam F..... 1′ 9″
Strata.....352′ 0″	Strata.....413′ 0″	Strata..... 54′ 0″
Sydney Main....3 to 6 ft.	Seam C..... 2′ 9″	Six Feet..... 6′ 0″
Strata.....260′ 0″	Strata.....219′ 0″	
W. Fraser..... 1′ 8″	Millpond..... 3′ 11″	
Strata..... 97′ 0″	Strata.....176′ 0″	
Indian Cove..... 5′ 0″	Black Rock... 3′ 0″	
Strata..... 94′ 0″	Strata.....126′ 0″	
Seam F..... 2′ 2″	Seam F..... 0′ 8″	
Strata.....112′ 0″	Strata..... 44′ 0″	
Stony..... 4′ 0″	Seam G..... 0′ 11″	

*Condensed from Mr. Fletcher's tabulation in "Descriptive note on Sydney Coal Fields." The correctness of the above correlation is questioned by some authorities. (Extracted from report on *Investigation of Coals in Canada*, Dept. of Mines, Mines Branch, 1912.)

Besides seventeen mines now in operation in Cape Breton, the Company has acquired and operates the collieries of the Cumberland Coal and Railway Co. at Springhill in Cumberland county. It also owns and operates the Sydney and Louisburg railway, which connects the mines with the shipping piers at Louisburg and Sydney harbours and owns a fleet of steamers engaged in transporting coal to the different maritime markets.

The following are brief descriptions of the different collieries in operation :*

Dominion No. 1 Colliery.

This mine is situated on the Sydney and Louisburg railway, about 10 miles from Sydney and 30 miles from Louisburg.

The Phalen or upper seam in this area is worked from a shaft, 24 ft. by 10½ ft., and 160 ft. in depth, and which is divided into two compartments, one for hoisting coal and the other for men. There are also an air shaft and a shaft for carrying the endless haulage ropes underground.

The seam has an average thickness of about 7½ ft., and contains a thin parting of "bone" about eighteen inches from the pavement. The dip is about 3½° to the east. There is a false roof over the coal consisting of a few inches of shale ; the main roof is sandstone, from 5 ft. to 8 ft. in thickness. The pavement is smooth and consists of a hard, sandy shale. The seam is extremely regular in character and no faults, except an occasional one of a local nature, are encountered in the workings.

The mine is developed by two main roads, the South deep and the Angle deep. The South deep is driven to the dip for a distance of about two miles to the barrier separating No. 1 workings from No. 2 Colliery. The Angle deep is driven at an angle to the dip for a distance of about two and one-half miles. The workings off the Angle deep are largely submarine and the present working face is about three-quarters of a mile beyond the shore line.

Method of Mining.—The method of working is pillar-and-stall. Levels are driven off the main deeps every 1600 feet. The main gangways are 20 ft. wide and the deeps, narrows, and headways are 12 ft. wide. The rooms are driven 20 ft. wide and vary from 400 ft. to 800 ft. in length. The level and room pillars are 40 ft wide and crosscuts, 12 ft wide, are driven every 66 ft.

In the submarine workings, the mine is divided into panels less than one-half square mile in area and bounded by 90-ft barrier pillars.

*In these descriptions, free reference has been made to different articles on the equipment of these collieries, written by F. W. Gray, and published in the Canadian Mining Journal.

As the South deep reaches the barrier of No 2 Colliery, the pillars are being drawn and the slope will be abandoned. These pillars are being drawn from the boundary towards the deep, and the line of pillar faces is kept so that it always makes an angle with the slope. The roof falls almost immediately and settles down tight on the cave. By drawing the pillars in this systematic manner, over 95 per cent of the coal is recovered.

In the submarine work, the pillars are not drawn and the present extraction in advance work is about 40 per cent, but they are of such dimensions that, when the boundary is reached and the mine is to be abandoned, they could probably be drawn in retreat. The maximum cover over the present submarine workings is about 500 ft.

Blasting Methods.—Humidity reports are made at several points in the intake and return air-ways, but the mine is naturally dry. Sprinkling is done by means of air pipes used as water mains, and also, in places, by tanks. Four-fifths of the production is machine-mined coal, the remaining fifth being mined by hand. The coal cutters used are operated by compressed air and are of the puncher and shearing types. The shooting is done by battery, Monobel and No. 6 high tension detonators. The tamping material is clay, the major portion being sent into the mine and the remainder dug there. The cuttings from the machines are loaded into cars and sent out of the rooms before shooting.

Ventilation and Lighting.—The mine is ventilated by a Capell fan delivering 175,000 cu. ft. of air per minute, a Murphy fan, which can be driven from the same engine, being held as a reserve. There are two equal splits in the air current, one going to each district and returning by way of the South and Angle deeps, respectively. The hoisting shaft is used as the upcast.

In timbering the mine 1½ lineal feet of props and booms is used per ton of coal mined.

The stables and pit bottom are equipped with electric lights, voltage 110, but, with these exceptions, Ackroyd and Best electrically-lighted safety lamps which burn kerosene oil are used exclusively underground. Stations for re-lighting these lamps are maintained in different portions of the mine.

Haulage.—Haulage on each of the main deeps is performed by endless rope, the engines being situated on the surface and the ropes carried underground by means of the material shafts. These engines are 28 in. by 60-in. stroke. Compressed air tail-rope haulage is used on some of the levels. A first motion engine 20-in. by 54-in. stroke, drum 8 ft. 9 in. in diameter, is used for hoisting out of the shaft. The cages used are of the self dumping type.

Forty-six-pound rails are used in the deeps, 30-pound rails in levels and headways and 18-pound rails in the rooms.

The mine is equipped with steam and electric pumps capable of discharging 1700 gals. of water per minute.

The boiler plant consists of five 212-h.p. and two 318-h.p. water tube boilers, which are fired with slack coal from the screening plant.

Compressed air for coal cutters and mine haulage is supplied by three air compressors, each having a capacity of 2500 cu. ft. of free air per minute.

Bankhead.—The bankhead is a steel structure, housed with corrugated iron, and fitted with shaking screens and picking belts. Three sizes of coal can be obtained :

Domestic—that which passes over a 2-in. bar screen.

Screened—that which passes over a ¾-in. net screen.

Slack—that which passes through the ¾-in. net screen.

The coal is loaded direct into 35-ton steel hopper and 15-ton wooden cars and shipped over the Sydney and Louisburg railway to the shipping piers.

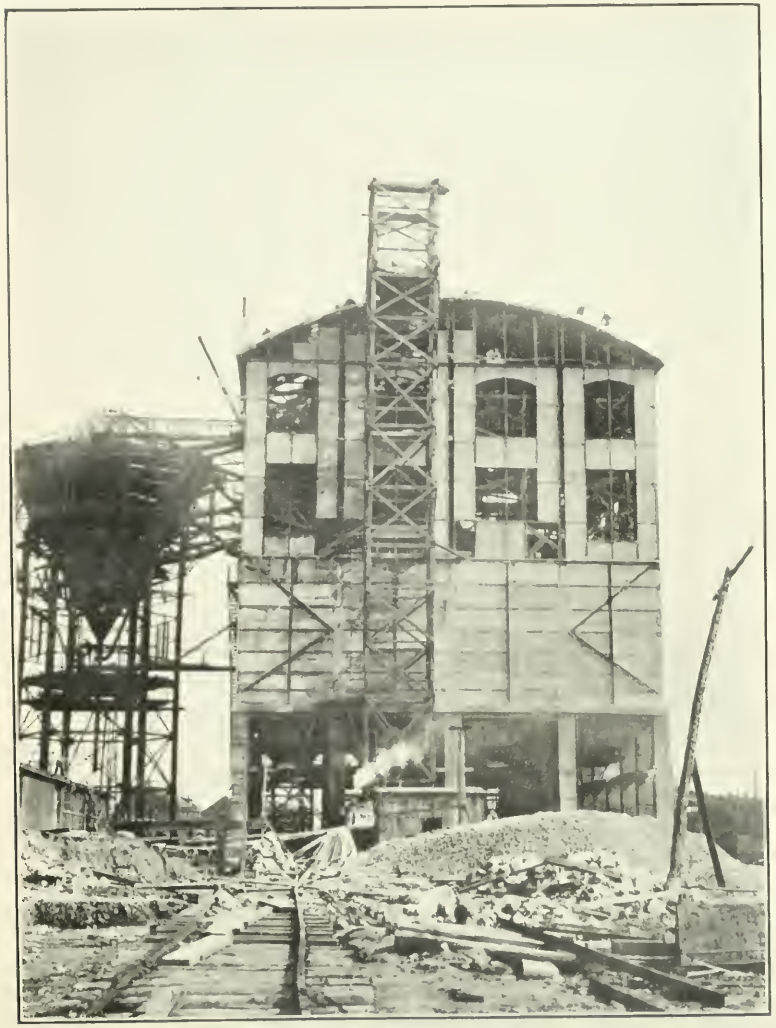
The mine has an output of about 2,000 tons per day. There are 490 men employed underground and about 100 above ground.

No. 2 Colliery

This colliery is situated on the main line of the Sydney and Louisburg railway at Glace Bay. It is the largest operated by the Dominion Coal Company, and one of the largest coal mines in America. The seam worked is the Phalen, having an average thickness of 7½ ft. and a dip of 4° to 5° to the eastward. The hoisting shaft is sunk near the outcrop of the Hub seam, and cuts the Harbour and Phalen seams at 405 ft. and 860 ft. from the surface, respectively. It is 37 ft. x 10 ft. wide to the Harbour seam, from which point it is 21 ft. x 10 ft. wide It is divided into five compartments, two for No. 9 Colliery, two for the No. 2, and one for a pipe compartment. The workings from this shaft on the Harbour seam are known as No. 9 Colliery.

The mine is developed by a pit-bottom level, 5000 feet in length ; headways and deeps have been driven from the level for the purpose of recovering the coal to the rise and to the dip.

System of Mining.—The system of mining is bord-and-pillar. Rooms are 20 ft. wide and from 300 ft. to 600 ft. in length ; pillars are from 48 ft. to 60 ft. thick, depending upon the cover, which varies from 700 ft. at the rise workings to 950 ft. in the submarine. The deepest workings are under the sea, one mile beyond the shore line.



Baum Washery, Dominion Coal Co., Sydney, N.S.

Steel Bankhead, No. 2 and No. 9 Collieries, Dominion Coal Co., New Aberdeen, N.S.

Some pillars have been drawn under the land area, but none have yet been drawn in the submarine.

Blasting Methods.—The mine is naturally dry, and humidity records are made at several points in the intake and return air-ways. Sprinkling is done periodically by means of air pipes used as water mains and also by water pipes laid for this purpose. In some sections, the dust is swept up and taken out of the mine.

The coal is mined by compressed air machines of the puncher type ; boring and shearing machines are used in narrow work. The shooting is done by battery, Monobel and No. 7 detonators. The tamping material is clay, which is sent into the mine. The cuttings from the machines are loaded into cars and sent out of the room before shooting.

Ventilation and Lighting.—The mine is ventilated by a Dixon fan (Guibal type) 24 ft. by 9 ft., belt driven from a steam engine, 20 in. by 42-in. stroke. A similar steam engine is installed as a spare. A Walker fan, 20 ft. by 6 ft. 6 in. and rope-driven from a steam engine, has now been installed to ventilate No. 2 and No. 9 Collieries. There are five splits in the air current ; two ventilating the rise workings on the north side ; one ventilating the rise workings on he south side ; and two ventilating the deep workings on each side.

Electric lights are used at the shaft bottom and for a short distance along the main roads, but, with this exception, Ackroyd and Best electrically lighted safety lamps are used exclusively underground. Relighting stations are maintained in different portions of the mine.

In timbering the mine, .22 lineal feet of props and booms are used per ton of coal mined.

Haulage.—Eight high-pressure compressed air locomotives are used in the levels. Compressed air hoists are used in the headways and deeps. The mine cars weigh 1850 pounds each, and have a capacity of 1.95 tons of coal.

The pit bottom is equipped with two units for handling the coal. The following is a brief description of one of these :

The loaded cars are gathered from the main roads and delivered to the shaft bot om by means of compressed air locomotives They are weighed, and then run by gravity on to a revolving tipple operated by compressed air. A catch, operated by the car, which permits only one car to enter and leave the scales at one time.

The coal is discharged from the tipple on to either of two inclined chutes, which have a capacity of 8 tons each, and which are placed opposite to each of the hoisting compartments in the shaft. The mouth of the chute is closed by a hinged door fastened by a catch. The hinge of the door is attached to a pulley over which a chain and counterpoise for closing the door is hung. The other end of the chain is fastened to the opposite side of the shaft, so that, when the door is shut the chain stretches across the shaft. When the hoisting tank is lowered almost to the bottom, the door latch is opened by the descending tank. As the tank is lowered still further, pulleys on the bottom of the tank engage the chain and draw down the door, which forms the lip of the chute. The coal is then discharged into the hoisting tank.

Any coal which falls from the chute and drops to the bottom of the shaft is lifted by a bucket conveyer to the level of the pit bottom and loaded into mine cars. As the tank is hoisted, a steel roller on the top of it closes the door of the chute.

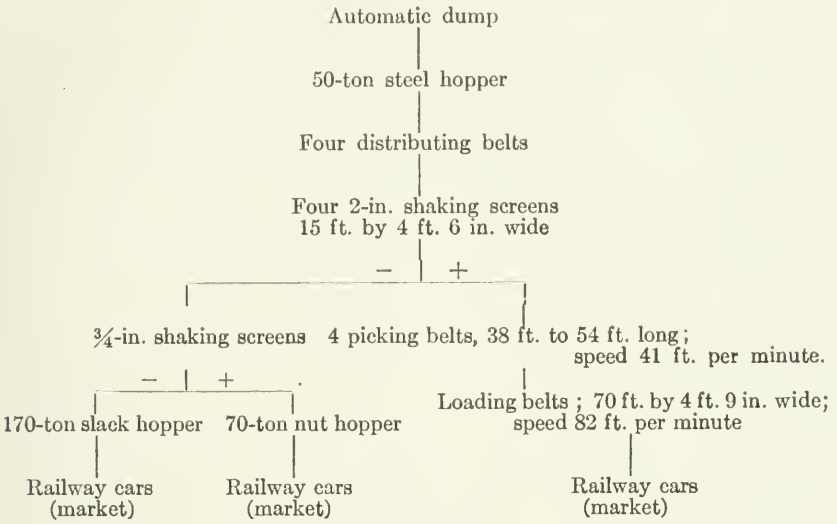
The hoisting tank has a capacity of 8 tons, but the actual average is about 6 tons. It has an inclined bottom and is mounted on a frame with its centre of gravity on the same side as the dump. There are two sets of guide spears for the tank, one for the framework guides and a smaller set for keeping it from dumping in case the lock slips while it is in transit. On reaching the dumping level, the lock is released by a catch on the framework guides and the tank lunges forward, tightening the side chains connected to the framework and door of the tank, while at the same time opening its door automatically, and allowing the coal to discharge into a 50-ton hopper.

Bankhead.—The bankhead is a large steel structure 132 ft. in height. It is covered with corrugated iron and contains the screening machinery for No. 2 and No. 9 collieries.

The following is a brief description of the screening operations :

The coal is fed from the hopper to four sets of shaking screens by means of four distributing belts set in the bottom of the hopper. The shaking screens are arranged so that domestic, nut, slack, or run-of-mine sizes of coal can be obtained. The shaking screens and picking belts are driven by a 75-h.p. motor. The loading belts are driven by a 40-h.p. motor.

The following illustrates graphically the plan of screening operations at No. 2 colliery :



This mine has an output of nearly 3000 tons per day. There are 800 men employed underground, and 96 above ground.

Additional Surface Machinery.—There is the following additional surface machinery :

One hoisting engine, with 34-in. by 48-in. cylinders and having a double conical drum 10 ft. and 13½ ft. in diameter, and 5½ ft. wide.

One man hoist with 24-in. by 42-in. cylinders and having a drum 8 ft. in diameter.

The boiler plant consists of twenty 318-h.p. water-tube boilers. They are fired by under-feed stokers, and the draft is obtained from two 8-ft. Sturtevant blowing fans. Compressed air for pumping and haulage purposes is supplied from a battery of compressors as follows :

One compound Walker air compressor, capacity 6300 cu. ft. of free air per minute ; size of cylinders, steam, 20 in. and 36 in. in diameter; air, 32 in. and 51 in. in diameter. The stroke is 60 in.

Three compound Rand air compressors, capacity 3000 cu. ft. of free air per minute; size of cylinders, steam, 20 in. and 36 in. in diameter; air, 20 in. and 32 in. in diameter ; stroke, 48 in.

Two Norwalk high-pressure air compressors, capacity 1380 cu. ft. of free air per minute.

The compressor-house is of steel-frame construction with walls of concrete and expanded metal. In 1906, an addition was made to this building to house the mine's central electric plant, whi h is described on page 62, under "Central Power Plants."

The surface equipment also includes machine shops, blacksmith shops and safety-lamp house.

No. 3 Colliery

This mine is situated on the outcrop of the Phalen seam about half way between No. 4 and No. 5 collieries. The workings from No. 4 and No. 5 collieries form the eastern and western boundaries of this mine, and No. 2 Mine workings form the boundary to the dip. It was opened in 1889, and commenced to produce in 1900. About 3,500,000 tons have since been produced.

The entrance to the mine is by a slope 9500 ft. long and 12 ft. wide driven on the dip of the seam, which is about 4° to the eastward.

System of Mining.—The method of working is pillar-and-stall. Levels are driven to the east and west of the main slope, 400 ft. to 450 ft. apart. The rooms are opened off the level and driven on the face of the coal which makes an angle of about 45° to the level. The rooms are 20 ft. wide and the pillars are 25 ft. to 30 ft. wide, depending on the cover. Crosscuts are driven every 60 feet.

There are 19 levels on the east and west side which extend for a distance of about 1200 ft. on each side of the slope.

The narrow work is almost completed and the pillars are now being drawn from the barriers in retreat. The work is being done in a systematic manner similar to that already described under No. 1 colliery, and practically no coal is lost.

Ventilating and Lighting.—The mine is ventilated by an electrically-driven Capell fan, the power being supplied from the central power plant. There are two equal splits in the air current, one going to the east of the slope, the other to the west. The main haulage slope is used for the return-air.

Ackroyd and Best safety lamps are used exclusively underground.

Haulage.—Haulage on the main slope is performed by endless rope. The endless-rope engine is situated at the bankhead, 4,500 ft. distant from the mouth of the slope, and has a total haul of nearly 14,000 ft.

The mine cars weigh 1895 lbs. and have a capacity of two tons. All water from No. 3 Mine is now being pumped into No. 4 Mine.

Surface Equipment.—The boiler plant consists of three 318 h.p. water-tube boilers fired with slack coal from the screening plant.

The bankhead is a wooden structure containing two rotary tipples, shaking screens, picking belts, etc., for making screened coal, nut and slack. The screening plant is driven by a steam engine 12 in. by 34-in. stroke. One Walker air compressor, capacity 6000 cu. ft. of free air per minute, furnishes power for coal cutting and pumping.

The mine has an output of about 500 tons per day. There are 147 men employed underground and 46 on the surface.

No. 4 Colliery

This colliery is situated on the Phalen seam at Caledonia. It was first operated in 1866, and has produced about 9,000,000 tons of coal. Of this amount, the Dominion Coal Company have produced 7,500,000 tons, or over 83 per cent, since 1893.

The mine is worked by a rectangular shaft, 18 ft. by 10 ft., and 185 ft. deep, sunk near the outcrop. The workings are divided into two districts by a pillar of coal that underlies Glace bay and a creek that flows into it. The east side workings are partly submarine and will be extended to the No. 6 colliery barrier pillar. The west side workings are bounded on the west by No. 3 mine barrier pillar.

The east side workings are developed by what is known as the East deep haulage slope 7000 ft. in length and the west side by the West deep haulage slope 9000 ft. in length.

The pillar-and-stall system of mining is used. The rooms are 20 ft. wide and the room pillars vary from 25 ft. to 35 ft. in thickness, depending on the thickness of cover. The maximum cover is 500 ft.

Some pillars have been drawn under the land area, but none have been drawn in the submarine. n timbering, 2½ lineal feet of props and booms are used per ton of coal mined.

Blasting Methods.—The mine is naturally wet, but humidity reports are regularly made at several points in the intake and return air-ways. Sprinkling is resorted to where necessary. The coal in rooms and narrow work is mined by compressed air machines. The shooting is done by battery and squib, Monobel and Bulldog powder.

Ventilation and Lighting.—The mine is ventilated by a Murphy fan delivering 95,000 cu. ft. of air per minute and is direct driven from a steam engine, the cylinder of which is 11 in. by 14-in. stroke. A Dixon fan, 14 ft. by 6 ft. 4 in. is held as a reserve. There are two splits in the main air current, one going to each district. The east side portion, which is split at No. 8 west level, ventilates No. 8 section and returns by way of the coal shaft. The lower split ventilates all the workings below No. 8 and returns by way of the air shaft at Bouthillier's shore.

Electric lights, voltage 110, are used at the pit bottom and East deep, but, with these exceptions, Ackroyd and Best electrically lighted safety lamps are used exclusively underground.

Haulage.—Endless rope haulage is used on the East deep and West deep, the length of hauls being respectively nearly 7000 ft. and 9000 ft. Main-and-tail ropes are also used on some of the levels.

A first-motion steam engine, 20 in. by 54-in. stroke, connected to a drum, 8 ft. in diameter, is used for hoisting the coal. The cages used

are of the ordinary self-dumping type. The man-hoist is a second-motion steam engine, size of cylinders 18 in. by 24-in.

The mine is equipped with electric pumps which discharge the water to the surface by means of bore holes. On the west side, there is an Aldrich five plunger pump, capacity 600 gals. per minute, and a Gwynne centrifugal pump, capacity 250 gallons. The east side is equipped with a McDougall turbine pump, capacity 420 gals. per minute. In addition, there is a water shaft, situated on the banks of Caledonia brook a short distance below the colliery, that is capable of hoisting large quantities of water. The electric ables are taken underground by means of bore-holes.

Power Plant.—The boiler plant consists of two 160-h.p. water-tube boilers, and five 218-h.p. water-tube boilers. Compressed air for mine haulage and coal cutting is supplied by two cross-compound air compressors, each having a capacity of 3000 cu. ft. of free air per minute. The bankhead is a steel structure housed with corrugated iron and contains the usual screening arrangements and picking belts.

The mine has an average output of 1400-1500 tons per day. There are 450 men employed underground and 78 above ground.

No. 5 Colliery

This mine is situated on the outcrop of the Phalen seam near Reserve Junction. The workings are bounded by No. 1 Mine barrier pillar on the north, No. 3 Mine barrier pillar on the south, and No. 2 Mine barrier pillar on the east. Since the mine was opened, in 1872, about 10,400,000 tons have been produced ; of this amount, the Dominion Coal Company have produced 8,900,000 tons, or 85.6 per cent, since the organization of the Company in 1893.

It has been worked through three main haulage slopes, namely, the French, Main, and East slopes. The French slope is the only one now in operation, as the pillars have been drawn in others. It is 11,000 ft. in length and has a pitch of 4½ degrees. The coal is approaching exhaustion and all the pillars are being recovered.

The Emery seam, situated about 140 ft. beneath the Phalen, is being worked at No. 10 Colliery and has the same bankhead as No. 5. The pillar drawing in the upper seam is kept about one mile in advance of the lower workings so that it will be possible to recover practically all the coal from them. The system of mining is the same as that in use in the mines already described.

Ventilation.—The mine is ventilated by two fans, one situated near the bankhead and the other at the mouth of the East slope, about one mile distant. The former is a Chandler fan, 15 ft. in diameter, driven by direct connection from a 16 in. by 22 in. steam engine. There

are two splits in this air current, one going to each side of the French slope. The East slope fan is of the Guibal type, 24 ft. in diameter, and rope-driven from a 16 in. by 22 in. steam engine.

Haulage.—Endless-rope haulage is used on the French slope as far as No. 9 landing, 9,000 ft. from the surface. From No. 9 landing to the bottom, ordinary trip haulage is used.

The boiler plant consists of seven water-tube boilers with a capacity of 1878 h.p. Power for mine haulage, pumping and coal cutting is supplied by two air compressors, capacity 2500 cu. ft. each, and one air compressor, capacity 3500 cu. ft. of free air per minute.

Surface Equipment.—The bankhead is a wooden structure and serves for screening the coal from No. 5 and No. 10 collieries. The coal is hauled from the mouth of the French slope on to the bankhead by means of a car haul, and is discharged by a Phillips dump on to a feeder belt which delivers it to the screens. The bankhead machinery is driven by electric motors, the power being supplied from the central power plant.

The surface equipment also includes a lamp house, machine shop, blacksmith's shop, and a carpenter's shop, for doing ordinary mine repair work.

The mine has an average output of about 1000 tons. There are 260 men employed underground and 65 on the surface.

No. 6 Colliery

This mine is situated near McRae point at the eastern and southern extremity of the Glace Bay coal basin. It was opened by the Dominion Coal Company in 1904, and the present output is about 1,200 tons per day. There are 258 men employed underground and 75 above ground.

As the seam worked—the Phalen—outcrops near the shore line, the territory is largely submarine ; the dip is about 6° towards the northeast.

The mine is developed from a main haulage deep driven for a distance of 5000 ft. from the outcrop. The bottom of the deep is about 1200 ft. beyond the shore line. The cover at the shore line is 375 ft. and submarine work is now being carried on.

The pillar-and-stall system of mining is in use. In the land area, the rooms are 20 ft. wide and the pillars 15 ft. thick. In the submarine area, the rooms are 20 ft. wide and pillars, 30 ft. in thickness. Headways 400 ft. apart are driven up to the pitch from levels, and the rooms are opened off at right angles to the headways. Some pillars have been drawn from a few places under the land area but no submarine pillars have been drawn.

Blasting Methods.—The mine is naturally wet, but humidity reports are regularly made at several points in the intake and return airways and sprinkling is resorted to where necessary. The coal in rooms and narrow work is mined by compressed air machines.

The shooting is done by Bulldog powder and squib, and clay dug in the mine is used for tamping.

Ventilation and Lighting.—The mine is ventilated by a 20 ft. by 7 ft. Walker fan delivering 52,000 cu. ft. of air per minute; water-gauge .8 in. The fan is rope-driven, from a 16 in. by 16 in. steam engine. It is steel cased, placed on concrete foundations and the fan engine-house is of fire-proof construction. There are two splits in the main air current, one going to each side of the slope. The main haulage slope is the return air-way.

Ackroyd and Best electrically lighted safety lamps are used exclusively underground.

Haulage.—Ordinary haulage is used on the main slope, 20 cars of 1¾ tons capacity being hoisted at one time. A duplex steam engine is used for hoisting. The cylinders have a diameter of 26 in. and a stroke of 48 in.; the diameter of the drum is 8 ft. and the width 4 ft. No. 3 level has plain haulage ; No. 4 and No. 5 levels have main-and-tail rope haulage, and No. 6 level has both plain and main-and-tail rope haulage.

The mine pumping is done by means of compressed air pumps which lift, on the average, 268,000 gals. per day.

Power Plant.—The boiler-house is of fire-proof construction and contains six water-tube boilers with a rated capacity of 1500 h.p. The draft is induced by means of Parsons forced draft blowers. An annex to the boiler-house contains the feed water heaters and feed pumps. The compressor house is also of fire-proof construction and contains two Walker air compressors, capacity 3500 cu. ft. of free air per minute each, which furnish power for coal cutting, pumping and mine haulage. An automatic oiling and filter system is installed in the compressor-house for oiling the compressors.

The cars are hauled from the mouth of the slope to the bankhead and returned by means of up and down automatic car-hauls. The coal is dumped into a steel hopper by means of a revolving side dump tipple and is fed from the hopper by means of two feed belts on to two sets of shaking screens fitted with 2-in. and ¾-in. perforations.

The lump coal is picked on picking belts and discharged into railway cars. The slack and nut coal are carried by a conveyer and discharged into separate cars.

No. 7 Colliery

This mine is situated near the shore line at Table head. The coal seam worked is the Hub, the highest known seam in the land area of Glace Bay basin. It derives its name from the outcrop, being the approximate centre of the semi-circular outcrops of the other seams in this coal basin. It underlies a small land area of about one-half square mile, but the extent of the submarine area is not definitely known. The workings are now over 5500 ft. beyond the shore line and are still advancing. The mine has an average output of 750 tons per day. There are 300 men employed underground and 50 above ground.

The seam was first mined in 1858 and the mine has been in operation for about thirty out of the succeeding fifty-four years. It has a thickness of 8½ ft., but is not so regular in character as some of the other seams. The general dip is 3° to 4°. The roof is shale and the pavement an impure fire-clay.

The mine is developed from the shaft by a main haulage deep 12 ft. wide and 8100 ft. in length. Pillars 34 ft. in thickness are left between the parallel deeps, and pillars 100 ft. in thickness are left on each side of the deeps.

Method of Mining.—The system of mining used is pillar-and-stall with panels in the submarine area. The rooms are 20 ft. wide and 500 ft. in length, between headways. The room pillars vary in thickness, depending on the amount of cover over the workings. The following table gives the thickness of pillars left in submarine work :

DEPTH OF COVER	WIDTH OF PILLAR
200 feet	28 feet
300 "	30 "
350 "	33 "
400 "	34 "
500 "	36 "

All rooms are 20 ft. wide ; crosscuts 75 ft. apart and not more than 12 ft. wide.

Nearly all the coal under the land area has been recovered except where the cover is less than 80 ft. and where pillars have been left to support buildings on the surface.

Blasting Methods.—The mine is naturally wet and sprinkling is not necessary. The coal is mined by compressed air machines of the puncher type. Bulldog powder and squibs are used for blasting the coal, and Monobel and battery are used for brushing the roof and floor. Clay, dug in the mine, is used for tamping.

Ventilation and Lighting.—The mine is ventilated by a Capell fan, 12 ft. by 11½ ft., delivering 60,000 cu. ft. of air per minute. The fan is belt-driven from a steam engine, 12 in. by 15-in. stroke.

There are two main splits in the air current, one ventilating the north side of the main deep and one the south side. The hoisting shaft is used as the up-cast.

The mine is practically free from gas. Electric lights, voltage 110, are used at the shaft bottom. Ackroyd and Best safety lamps are used exclusively by the miners and workmen.

Haulage.—The coal shaft, 130 ft. deep, is divided into three compartments, two for coal hoisting and one for hoisting the men. The ordinary self-dumping cage having a capacity of one car is used in the coal shaft. The track gauge is 26 in. and the mine cars have a capacity of two tons of coal. The coal-hoist is a duplex steam engine, size of cylinders 24 in. by 42-in. stroke ; drum, 8 ft. in diameter by 6 ft. face.

The man-hoist is operated by a duplex steam engine, size of cylinders 18 in. by 36-in. stroke.

The endless-rope haulage used on the main deep, is actuated by an engine near the shaft bottom, which is driven by a 200-h.p. variable speed induction motor using current at 550 volts. The transmission cables are taken underground by means of a bore hole.

Mine Equipment.—The mine is equipped with a number of compressed air pumps situated on the different levels, as well as with two electric pumps situated underground near the shore line, which have a combined capacity of 1050 gals per minute. The transmission cables and discharge pipe are taken underground by means of bore holes. The boiler plant consists of two 250-h.p. and two 212-h.p. water-tube boilers.

Compressed air for coal cutting, mine haulage and pumping is supplied by two air compressors, each having a capacity of 2000 cu. ft. of air per minute. The bankhead is constructed of wood and contains shaking screens, and picking belts, driven by electric motors, similar to those in the other collieries.

The mine has an average output of 750 tons per day, and employs 300 men underground and 50 above ground.

Screening Plant.—As the St. Lawrence river is closed to navigation for five months of the year, it is not possible during that period to market this coal at the St. Lawrence ports. Sydney harbour freezes over from one to three months in the year and Louisburg, which also occasionally freezes over, are used as the winter shipping ports. It is, therefore, necessary to bank coal during the winter months at the banking station near No. 2 colliery. Thus, during the winter of 1911,

350,000 tons of coal were banked. Later, it is dug from the bank and loaded in railway cars by means of steam shovels, the railway cars are hoisted up a long inclined trestle to the re-screening plant at No. 7 colliery, where the slack is removed.

No. 8 Colliery

This colliery is situated on the Harbour seam at Bridgeport. Since operations began in this area in 1858, about 5,000,000 tons of coal have been produced. Of this, the Dominion Coal Company has produced 3,200,000 tons or 64 per cent. It has a daily output of 700 tons. There are 220 men employed underground, and 60 above ground.

The mine is worked by a retangular shaft, 6 ft. by 14 ft. and 80 ft. deep, sunk near the outcrop of the Harbour seam. The seam is 5 ft. thick and dips 4° and 30′ to the eastward. There is a false roof of shale over the coal and the main roof is sandstone ; the pavement is soft clay.

System of Mining.—The mine is developed by levels and deeps, the levels being driven 500 ft. apart. The system of mining used is pillar-and-stall. The rooms are 20 ft. wide and vary from 300 ft. to 500 ft. in length. The pillars are 20 ft. wide. Some of the pillars are now being drawn in a similar manner to that already described under No. 1 and No. 3 Collieries.

There are no submarine workings in this mine. In timbering, two lineal feet of props and booms are used per ton of coal mined.

Blasting Methods.—The mine is naturally wet and sprinkling is not necessary. It is free from gas. Only hand picks are used for mining. The shooting is done by means of compressed powder in pellets ; squibs are used as igniters.

Ventilation and Lighting.—The mine is ventilated by a Capell fan, 7 ft. by 10 ft., delivering 40,000 cubic feet of air per minute. The fan is belt-driven from a 9 in. by 12-inch steam engine. The ventilating current is continuous and the hoisting shaft is used as the upcast.

Electric lights are used at the shaft bottom, but, with this exception, Marsaut safety lamps are used exclusively underground.

Haulage.—A first motion duplex steam engine, 15 in. by 30-in. stroke, drum 6 ft. in diameter, is used for hoisting from the shaft. The cages used are of the ordinary non-dumping type having a capacity of one loaded car each. The track gauge is 32 in. and the cars have a capacity of about three-quarters of a ton. Endless-rope haulage is used underground. It has a speed of 2¼ miles per hour and is driven by a steam engine 18 in. by 36-in. stroke, geared 18 to 95. The water is taken from the mine by means of an electric water hoist. The boiler plant consists of one 300-h.p. and one 212-h.p. water-tube boilers.

The bankhead is constructed of wood and contains the usual 2-in. and ¾-in. shaking screens for screening the coal.

Water-Shaft.—A water shaft 379 ft. deep was sunk near No. 8 colliery for the purpose of hoisting the water from this mine. The hoisting is done by an Ilgner electric hoist, power being supplied from the central power plant. The line voltage is 7000 a.c., converted to 420 volts d.c. by means of a motor generator set. Attached to the main shaft of this set is a heavy flywheel which stores up enough energy to supply power for hoisting three tanks for use in case of accident to the transmission line. As the hoist is fitted with automatic cut-off and overwinding stop, the operator has only to reverse the current each time the tank is hoisted or lowered. Two tanks of 800 gals. capacity each, are hoisted per minute.

No. 9 Colliery*

This colliery is working the Harbour seam which has an average thickness of about 5½ ft., and dips about 4° 6′ to the eastward.

The roof consists of a few inches of hard dark shale over the coal, then 3 in. to 4 in. of flinty shale ; and 14 ft. of shale to a sandstone post. The pavement is soft clay. The system of mining is similar to that in use at the other mines. The face of the workings is now extended for a considerable distance under the sea. As the land pillars are always drawn from 600 to 700 ft. in advance of pillar work in No. 2 Mine, the coal from both seams is recovered. No submarine pillars have yet been drawn.

In timbering the mine, 1.7 lineal feet of props and booms are used per ton of coal mined.

It has an output of 1100 tons per day. In all, 582 men are employed underground, and 60 above ground.

Blasting Methods.—The mine is naturally wet and sprinkling is not necessary. The coal is mined by machines and the blasting is done by battery and squib, and Monobel and Bulldog powder.

Ventilation and Lighting.—The mine is ventilated by a Walker fan, 24 ft. by 7½ ft., delivering 200,000 cu. ft. of air per minute. The fan is driven by a 16 in. by 30-in. steam engine and a similar engine is installed and held in reserve. A new Walker fan has now been installed to ventilate both No. 2 and No. 9 Mines.

Ackroyd and Best safety lamps are used underground.

Haulage.—The coal is hoisted to the surface by means of a first-motion hoist ; size of cylinders, 24 in. by 42-in. stroke ; drum 8 ft. in diameter and 30 in. wide. This hoist is to be replaced by a new one. Ordinary self-dumping cages are used in the shaft.

*See also a brief reference to this mine under No. 2 colliery, p. 42.

The underground haulage is performed by compressed air locomotives which convey the coal from the head of the south deep to the pit bottom, a distance of 2000 ft.; and by compressed air hoists operating plain haulage, and main-and-tail rope haulage on the deeps, headways, and levels. The cars weigh 1800 lbs. and have a capacity of 1.85 tons of coal.

The mine is equipped with compressed air and electric pumps, discharging 504,000 gals. of water per day.

Compressed air for coal cutters, pumping and mine haulage is supplied from the air compressors at No. 2 Mine.

No. 9 Colliery has the same bankhead as No. 2, but is equipped with separate screening arrangements.

No. 10 Colliery

This mine is opened up by a shaft, 170 ft. deep, sunk by the Dominion Coal Company, in 1906, near the entrance to No. 5 Mine. The seam worked is the Emery, which is the lowest seam worked by the Company in this area, and is about 160 ft. to 180 ft. beneath the Phalen seam. It varies from 2 ft. to 5 ft. in thickness, with an average thickness of about 4 ft. 2 in. The coal is hard and stands handling better than that from the upper seams. The false roof consists of 5 ft. of sandy shale ; the main roof is sandstone. The pavement is soft clay.

As the seam is so thin, and as it was necessary to take down a portion of the roof to get head room, it was found advisable to work by the longwall method and to use the material from the roof and floor for constructing pack-walls and goaf to support the roof after the coal had been extracted. The mine is developed by two main haulage roads—main north level and main north deep. The main north level is driven from the pit bottom parallel to the strike of the coal for a distance of 2,500 ft. The workings to the rise of this level are known as the pit bottom section. The main north deep is driven from the north level towards the dip for a distance of about 4000 ft. Three levels have been driven off this slope, but, as one has been cut off, only two are at present in operation.

System of Mining.—The system of mining is advancing longwall, the coal face being over one mile in length. Main gateways are opened off the levels about 800 ft. apart, there being three main gateways on each level. Cross gates are driven off the main gateways, 200 ft. apart and making an angle to the rise. The gate roads, 100 ft. apart, are driven off the cross gates, parallel to the main gateways. The packing is kept about 12 ft. from the coal face and a row of posts is maintained

between the packing and the face. The coal is undercut by Diamond longwall machines, the depth of cut being about 5 ft. 8 in. The mine has an output of about 900 tons per day. There are 200 men employed underground on the day shift and 107 on the night shift.

Blasting Methods.—Bulldog powder and squibs are used. The coal cutting, brushing and packing is done on the night shift. The mine is naturally damp and sprinkling is not necessary.

Haulage.—The haulage on the deep is by endless rope. Main-and-tail rope haulage is used on the levels. Main-and-tail rope haulage is used on some of the main gateways, but pony haulage is used on others. When the haul is great, pony haulage is very unsatisfactory. The mine cars have a capacity of 1400 lbs. of coal.

Ventilation.—The mine is ventilated by a belt-driven Stines fan delivering 38,000 cu. ft. of air per minute. The water gauge is .4 in. The air current is split at the bottom of the air shaft ; one split ventilates the pit bottom section, while the other goes down the stone drift from the Phalen seam to the bottom of the main deep where it is again split, one current ventilating the old east workings and the other No. 2 section.

The coal is hoisted to the surface by means of the ordinary non-dumping cage having a capacity for two cars. The cars are pushed off the cage and screened on the same bankhead that contains No. 5 Mine screening machinery.

Power Plant.—Power for mine haulage and coal cutting is supplied by the power plant described under No. 5 Mine.

Coal Mines in Lingan-Victoria Areas

This coal-field extends from Indian bay on the east to the eastern entrance of Sydney harbour on the west, and comprises a land area parallel to the shore line and an extensive submarine area, the limits of which are at present unknown.

The following table shows the thickness of the coal seams in the Lingan-Victoria areas and their relation to the seams in the Glace Bay basin.* It may be noted that there are at least eight workable seams in these areas :

* *Mining and Transportation*, Dominion Coal Co., Ltd. A General Description, by F. W. Gray.

THICKNESS OF COAL SEAMS, LINGAN-VICTORIA AREAS

Lingan-Victoria			Glace Bay	
Seam	Measures	Total Depth	Seam	Measures
Carr	3 ft. 0 in.			
	170 " 0 "			
McNeil	3 " 5 "	176 ft.		
	341 " 0 "			
Barachois	6 " 0 "	523 "	Hub	9 ft. 6 in.
	55 " 0 "			
Dunphy	3 " 0 "	581 "		404 " 0 "
	306 " 0 "			
Victoria	7 " 0 "	894 "	Harbour	5 " 6 "
	257 " 0 "			253 " 0 "
Fairy Harbour	3 " 5 "	1154 "	Bouthillier	3 " 9 "
	66 " 0 "			73 " 0 "
Northern Harbour	5 " 0 "	1225 "	Black Pit	2 " 7 "
	113 " 0 "			115 " 0 "
Lingan	8 " 0 "	1346 "	Phalen	8 " 6 "
	134 " 0 "			160 " 0 "
Emery	2 " 8 "	1483 "	Emery	4 " 6 "
	1,000 " 0 "			
Mullins	6 "			

Previous to the opening of No. 12 Mine by the Dominion Coal Company, in 1908, the Lingan and Victoria seams were the only ones worked, and the total yield of the whole field had not exceeded 2,000,000 tons. The importance of this field as a future coal producer may be judged from the fact that the eight workable seams have been estimated to contain 400,000,000 tons of coal. It contains Mines Nos. 12, 14, 15 and 16, situated near the town of New Waterford.

No. 12 Mine

This mine was opened up in 1908 by slopes driven from the outcrop of the Victoria seam, about one-half mile from the shore line. The seam has an average thickness of about 6 feet, and a dip of 10° 30′ to the northeast. There is a false roof over the coal, consisting of about two feet of shale, but the main roof is sandstone. The pavement is smooth and consists of a hard sandy shale and sandstone. The mine is developed by a main slope 3,600 ft. in length, from which levels are driven to the east and west every 500 feet.

System of Mining.—The system of mining is pillar-and-stall, and, owing to the greater dip of seams in this area, balances are used for lowering the coal from the rooms to the levels. Balances, 12 ft. wide,

are driven to the rise from levels every 400 ft. to 800 ft., depending on the dip of the seam ; rooms 20 ft. wide are driven off the balances, the room pillars being from 20 ft. to 35 ft. in width, depending upon the amount of cover. The coal is mined by compressed air machines of shearing, boring and puncher types.

The system of timbering is props-and-caps and props-with-booms. About 1.1 lineal feet of props and booms are used per ton of coal mined. The mine has an average output of 1200 tons per day. There are 354 men employed underground, and 57 above ground.

Blasting Methods.—Humidity reports are made at several points in the intake and return airways, but, as the mine is naturally wet, sprinkling is not considered necessary. The explosive used is Monobel powder and the shooting is done by battery and No. 6 low-tension detonators. The tamping material is clay, the major portion of which is sent into the mine ; the remainder is dug in the mine. All cuttings from the machines are loaded into cars and sent out before shooting.

Ventilation and Lighting.—The mine is ventilated by a rope-driven Walker fan 8 ft. by 11 ft. in diameter, delivering 100,000 cu. ft. of air per minute. The fan engine is a 95-h.p. steam engine. There are two splits in the ventilating current, one split going to the east side and one to the west. The main slope is used as the return.

The stables and main slope are equipped with electric lights, but, with these exceptions, Ackroyd and Best electrically lighted safety lamps are used exclusively underground.

Haulage and Power.—The mine cars weigh 640 lbs. and have a capacity of one ton. Single and double self-acting balances are used for lowering the loaded cars from rooms to the levels. Horse haulage is used on the levels. Trip haulage is used on the main slope—18 loaded cars being hoisted at a trip. The size of the engine cylinders is 30 in. by 48 in. stroke ; the drum is 8 ft. in diameter and the haulage rope is one inch in diameter.

Mine Equipment.—Compressed air pumps are used for mine pumping, but electric pumps have been installed for pumping the water from the main lodgement.

The boiler plant consists of two 250-h.p. and two 210-h.p. water-tube boilers. As the Waterford Power plant is completed, all the collieries in this district are operated by electricity, with the exception of the hoist and fan at No. 12 Mine.

Compressed air for coal cutters and pumping is supplied by an electrically driven compound air compressor, having a capacity of 3,300 cu. ft. of free air per minute. The air compressor—cylinders, 30 in. and 19 in. by 30-in. stroke—is direct driven from an induction motor using

current at 50 amperes and 6,600 volts. The air-compressor equipment also includes two small steam-driven air compressors of 400 cu. ft. and 600 cu. ft. capacity, respectively.

Bankhead.—The bankhead is a wooden structure sheeted with corrugated iron and fitted with two revolving side dump tipples, picking belts and shaking screens, capable of handling 1,500 tons per day. The surface equipment also includes carpenter, forge, and machine shops necessary for doing ordinary mine repair work.

No. 14 Mine

This mine is situated on the outcrop of the Victoria seam, one mile to the east of No. 12 Mine, and about one-half mile from the shore line. The dip of the seam is 19°30′ near the outcrop, but it flattens out to 10° towards the dip. The main slope is 3000 ft. in length and the method of mining is similar to that described under No. 12 Mine.

Mine Equipment.—The machinery at this mine is driven by electricity generated at the central power plant at Glace Bay, and includes the following machines :

One electric driven air compressor for coal cutting and for pumping similar to that already described, supplying power to mines No. 14 and No. 15.

One induction motor, 94 amperes, 550 volts, for driving a 6 ft. by 11 ft. Walker fan for ventilating the mine.

A number of small motors for operating the tipples, shaking screens, loading belts, car hauls, etc.

The electric hoist is the largest of its kind in Canada. The equipment consists of a motor generator set, driven by an 800-h.p. induction motor, having a voltage of 2200. Connected to the same shaft is a direct current generator, having a maximum voltage of 600, for supplying power to the hoist motor, and an 18.5-k.w., 220 volt, direct current generator for exciting the fields of the direct current machines. The hoist motor is direct connected to a winding drum 9 ft. in diameter. It works up to a peak load of 1300 h.p. when starting, and has a full load speed of 72 r.p.m.

Hoisting.—The speed of hoisting is regulated by what is known as the Ward-Leonard control system, a brief description of which is given herewith :

The current passing through the field of the main direct current generator may be regulated from zero to its full value by means of a suitable regulator, consequently the current delivered to the hoisting motor (which is excited at a constant value), and hence the speed of the hoist motor is practically proportioned to the field excitation of the direct current generator. It can be seen that, if the direction of this field

current be reversed, the polarity of the main direct current generator, and thus the polarity and direction of rotation of the hoisting motor, is also reversed. By reducing the field excitation of the generator during hoisting at full speed the momentum of the load and revolving parts tends to keep the hoisting motor running at full speed. The voltage of the generator having fallen, the hoist motor acts as a generator and the generator as a motor, thus exciting a powerful braking action until the speed of the hoisting motor becomes altered to correspond to the new conditions and the system becomes balanced.

In lowering the empty cars, braking can also be done regeneratively, and, consequently, with a smaller application of the mechanical brakes; also, if the energy so derived by the hoist motors acting as a generator is sufficient to drive the motor generator set slightly above synchronous speed energy is pumped back into the line. An electrically driven air compressor furnishes air for operating the mechanical brakes.

A depth indicator prevents the driver accelerating too quickly and stops overwinding.

No. 15 and No. 16 Mines

These mines are situated on the outcrop of the Lingan seam, No. 15 and No. 16 Mines being 400 ft. east of No. 14 and No. 12 Mines, respectively. The Lingan seam at these collieries has an average thickness of 5 ft. 4 in., and a dip of 18° to 19° to the eastward.

The slopes at No. 15 and No. 16 Mines are 2500 ft. and 2000 ft. in length, respectively, and the method of mining is similar to that already described. As these mines have been in operation for only a short time the average daily output is about 1000 tons per day each, but this will be increased to 1300 tons per day. The entire equipment of these collieries is electrically operated, including air compressors, coal hoist, ventilating fan, bankhead machinery, screening plant and underground pumps.

No. 21 and No. 22 Mines

These mines are situated on McAulay seam in the Morien basin. The geological structure of this basin is an eroded syncline and the mines are worked by slopes driven from the outcrop on one side of the syncline to the outcrop on the other side. The dip on the south side outcrop is greater than the dip of the north outcrop.

No. 21 Mine

This mine is developed by a slope 2000 ft. in length, the dip on the south side being 7° for 1800 ft.; and on the north side 30° to 40° for 200 ft. The following is a section of the coal seam:

Top coal ..... 1 ft. 9 in.
Shale ..... 1 ft. 1 in.
Bottom coal ..... 5 ft. 6 in.

The roof is shale and the floor is impure fire clay. All the machinery at this mine is driven by electricity generated at the central power plant. The maximum cover over the workings is 150 ft.

System of Mining.—The system of mining is room-and-pillar. The rooms are 30 ft. wide and the pillars 30 ft. thick. The mine was put in operation in January, 1913, and employs 32 men on the surface and 155 underground.

Blasting Methods.—Safety lamps are used underground and the blasting done by Bulldog powder and squibs : Monobel powder is used in wet places.

Ventilation.—An electric driven Stine fan, 12 ft. in diameter, delivering 50,000 cu. ft. of air per minute with one-half inch water gauge, is used for ventilating the mine.

The haulage system is endless rope 4300 ft. long, driven by a 50-h.p. motor.

The bankhead is of wooden construction with concrete floors, and contains the necessary tipples, shaking screens, picking belts, etc., for making the ordinary sizes of coal. The screens and picking belt are driven by a 20-h.p. motor, while a 10-h.p. motor operates the car haul.

Compressed air for coal cutting is furnished by electric driven air compressor of 1000 cu. ft. capacity.

No. 22 Mine

This is a new mine and was put in full operation in November, 1913. All the power used is furnished by electricity from the central power plant.

System of Mining. — The system of mining is room-and-pillar with a couple of advancing longwall faces. The length of these faces is 100 feet. The pillars are 30 feet and rooms 25 feet wide ; pillars to be drawn as soon as room is finished. The seam is 5 ft. 5 in. thick and has a dip of 7°.

There are 30 men employed above ground, and 170 underground. Ackroyd and Best safety lamps are used underground

Ventilation.—The mine is ventilated by a Sirocco fan, 70 in. in diameter, with single inlet, electrically driven, giving 50,000 cu. ft. of air per minute with a water gauge of .7 in.

Endless rope haulage is used underground. Power for underground work is supplied by a 3000 cu. ft., electrically driven, air compressor.

CENTRAL POWER PLANTS

Operating the Mines of the Dominion Coal Company in the Glace Bay, Morien and Lingan Coal Basins

The Dominion Coal Company has effected great economies in the generation and transmission of power. In so far as possible, no fuel, except slack coal and refuse from the picking belts, is used to generate power. The present policy is to generate electricity at central power plants and distribute it to the surrounding collieries, thus, wherever possible, supplanting steam power by electric. Thus, electric power is now being used on the surface for lighting, operating air compressors, hoists, fans, bankhead machinery, machine shops, etc. The use of electricity underground has been confined to lighting pit bottoms and some of the main roads, and to the operation of motor-driven pumps and haulages, placed in steel and concrete lined stations. By means of bore holes, the transmission lines are carried underground to the operating points. Thus, although electricity is used underground to a certain extent, no new danger has been created by the use of electricity at the coal-face or for electric locomotive haulage.

There are two power plants in operation—the central power plant serving the Glace Bay collieries, and New Waterford plant serving the Lingan collieries. The following is a brief description of these plants :

Central Power Plant

This plant, erected in 1906 as an addition to the compressor plant of No. 2 colliery, contains four generating units. Three units each consist of 550-k.w., 25-cycle, 3-phase, 6600-volts, alternating current generators, connected directly to 700-h.p. compound steam engines ; the high-pressure cylinders being 20 in. in diameter and the low-pressure cylinders 40 in. in diameter, and the stroke 26 in. The generators are excited by 75-k.w. direct current generators driven by 12 x 12 steam engines.

The fourth unit was added in 1908 and consists of a 1000-k.w. exhaust steam turbo-generator.

The transformer houses at the collieries are built of hollow glazed earthenware blocks. A typical house is 13 ft. high by 23 ft. long and 17 ft. wide. The roof is sloping and made of 4-ply, 1¼-in. T. & G., covered with tar and gravel finish.

New Waterford Power Plant

This plant is situated at Waterford lake, a few miles to the west of the collieries in the Lingan district. The power house is a substantial brick building 51 ft. by 78 ft., and 28 ft. high. It contains two 2000-k.w. turbine driven generators having a momentary overload

capacity of 4000 k.w. each. The boiler house is also a brick building 54 ft. by 58 ft., with posts 48 ft. in height. As the boiler installation consists of three Bettington boilers, the first of their kind to be installed in America, this plant is of great importance from the standpoint of conservation. They are fired by slack coal which could not be economically used to generate power in the ordinary boiler. Each boiler has a normal evaporation from and at 212° Fahrenheit of 20,000 lbs. per hour. The diagram at page 64 shows a sectional view of one of these boilers.

Bettington Boilers.—The essential features of this type of boiler are :

1. Pulverizer and blower.
2. Dust separator chamber.
3. Water cooled nozzle or tuyere.
4. Vertical water-tube boiler.
5. Air heater.

The coal is fed automatically to the pulverizer which also acts as a blower. The air before being drawn into the pulverizer is heated by means of an air heater placed in the path of the waste gases from the boiler. By pre-heating the air, coals containing up to 15 per cent moisture can easily be disintegrated and burned.

The coal, after being disintegrated, is delivered into the dust separating chamber, the fines passing direct to the fuel nozzle and the coarser particles returning by gravity to the pulverizer for further reduction.

The fine coal delivered at the nozzle and which, practically speaking, may be considered as a gas, is ignited and burns in the combustion chamber of the boiler. The heated gases pass from the combustion chamber up between the water tubes, through the economizer and air heater to the stack. The boiler consists of top and bottom headers with solid drawn steel tubes connecting them. Special bricks in combination with the innermost circle of tubes form the wall of the combustion chamber. No binding material is employed for these special bricks. The combustible matter in the fuel is said to be consumed and the residue is an irreducible vitreous slag. The slag solidifies at a relatively high temperature and soon chokes up and hermetically seals all crevices, cementing the lining into one solid piece. The bulk of the slag falls down into the ash pit below in the form of small globules which are easily removed, the quantity being very small in comparison to ashes from an ordinary hand-fired boiler. The steam, before passing to the turbines, is superheated by means of pipes spirally wound around the boiler tubes.

The advantages claimed for this type of boiler are :

1. The boilers will give an efficiency not given by any other boiler on the market.
2. They can be fired at any desired rate by adjusting the feed of the pulverizer.
3. They are easily cleaned.
4. After being closed down for a time, full steam can be generated quickly.

The power generated at this plant passes into the main transmission line, and, in conjunction with that from the Central power plant, serves all the collieries of the Dominion Coal Company situated in the Glace Bay, Morien and Lingan coal-basins.

Springhill Collieries

The Dominion Coal Company is operating three mines in the Springhill coal-field, in Cumberland county, N.S. These mines were formerly owned and operated by the Cumberland Coal and Railway Company.

The company also owns and operates a railway line which connects the collieries with the Intercolonial railway on the north at Springhill Junction, a distance of five miles, and, on the south, it terminates at Parrsboro on the Minas basin, 32 miles distant, where well equipped shipping wharves have been constructed.

The following section shows the relative position of the three seams worked by this company :

No. 3 Mine or North seam, 11 ft. to 4½ ft. thick; measures, 250 ft.

No. 1 Mine or East seam, 9 ft. to 5 ft. thick ; measures, 100 ft.

No. 2 Mine or West seam, 10½ ft. to 5 ft. thick.

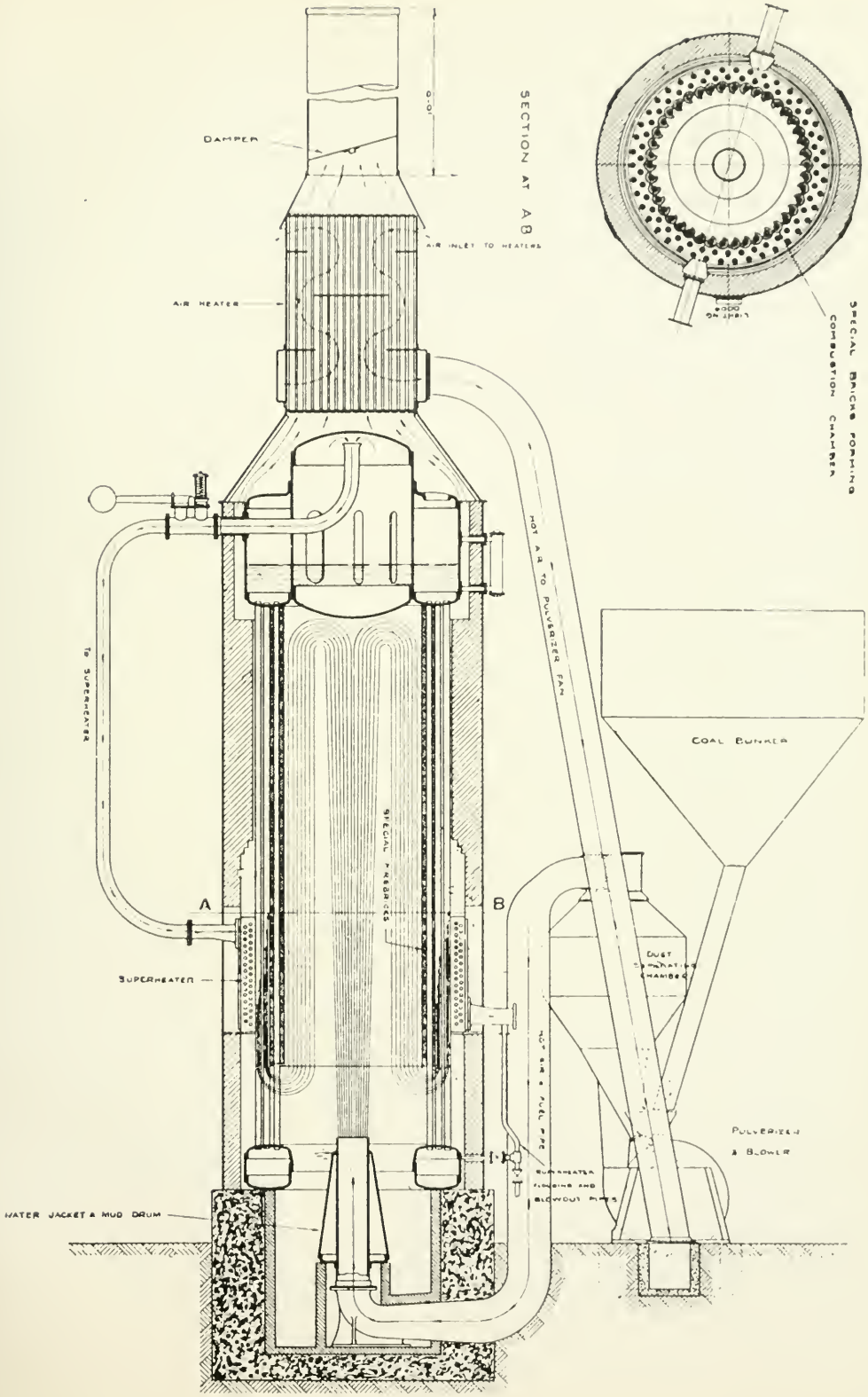
The dip is steep, averaging from 20° to 35°, and reaching 80° in places.

In the early days of mining in this field, considerable coal was lost through the workings in the lower seam being carried on too far ahead of those in the upper seam, and also because the pillars were small and were left standing too long.

The present practice is to drive narrow rooms and leave wide pillars so that, if portions of the dip side of the pillars fall, there will still be a sufficient thickness of pillar left to hold the roof until the rooms are completed and the pillars drawn.

No. 2 Mine

No. 2 seam is the lowest seam worked by the company. It has a thickness of 10 ft. 4 in. on the east side of the slope and a thickness of about 5 ft. on the west side. The dip varies from 20° to 80°. The roof



Sectional Elevation and Cross Section of Standard Boiler, Showing Path of Gases

and the pavement are hard shale. The main slope is 5400 ft. in length and has an average dip of 30°. The levels in operation are the 3300-feet and the 4000-feet. Two more levels are now being started below the 4000-feet level. No. 1 seam is also worked from No. 2 slope and, previous to the opening of No. 1 mine seam, by crosscuts from No. 2 seam, it had not been worked for about fifteen years. The levels in operation in No. 1 seam are the 2800-feet and 3300-feet.

System of Mining.—The system of mining used is bord-and-pillar. Levels are driven from the main slope every 600 ft.; chutes or balances are driven to the rise from levels 600 ft. apart. In all new work, the bords are driven 10 ft. wide and the pillars are 50 ft. thick.

Blasting Methods.—The mine is gaseous and dry in certain sections and no explosives are used for blasting the coal. Sampsonite and battery are used in rock work, but shooting is not done until the place where the shot is to be fired is well watered to keep down the dust. This shooting is done only when the men are out of the mine.

Ventilation and Lighting.—The mine is ventilated by a Capell fan, 18 ft. by 4½ ft., situated at No. 2 slope and delivering 150,000 cu. ft. of air per minute ; also by a similar fan placed at the return air-way at Aberdeen slope. These fans are driven by 20 in. by 20-in. steam engines. Marsaut safety lamps are used exclusively underground.

Haulage.—The coal is hoisted in trips of 12 boxes each. The hoist is operated by a first motion, double drum, slide-valve engine; size of cylinders 30 in. by 48-in. stroke ; diameter of drum 7½ ft. Horse haulage is used on the levels in No. 2 mine and main and tail-rope haulage on one of the levels in No. 1 seam.

Bankhead.—The bankhead is a wooden structure sheeted with corrugated iron. It is equipped with two end-dump tipples, three side-dump revolving tipples, three shaker screens, picking belts, conveyer, etc.

The following sizes of coal can be obtained :

1. Run-of-mine.
2. Screened—that which passes over a ½-inch screen.
3. Culm—that which passes through a ½-in. screen.
4. Double X—that which passes over a ¾-in. screen.
5. Slack—that which passes through a ¾-in. screen.

The boiler plant consists of six 150 h.p. double flue boilers, two 176 h.p. Lancashire boilers and four 200-h.p. Robb-Mumford boilers.

No. 3 Mine

No. 3 seam is the uppermost seam in the series and varies from 10½ ft. in thickness on the west side, to 4½ ft. on the east side. The

dip varies from 20° to 60°. The main slope is 4800 ft. in length, but only the 2600-feet, 3300-feet, and 3800-feet levels are being worked at present. The system of mining is the same as that described under No. 2 Mine.

VENTILATION.—The mine is ventilated by a Capell fan, 22 ft. by 3½ ft., delivering 150,000 cu. ft. of air per minute. The fan is driven by a 24 in. by 24-in. steam engine.

BANKHEAD.—The bankhead is equipped with shaker-screens, picking belts, etc., for handling an output of 2000 tons of coal per day. The coal sizes obtained are screened coal and culm. The surface plant also includes blacksmith shop, carpenter shop and machine shops necessary for doing ordinary mine and railway repair work.

These collieries have a combined output of about 1400 tons of coal per day.

BY-PRODUCT COKE-OVEN PLANT

The coke-oven plant operated by the Dominion Iron and Steel Company is situated at Sydney near the company's iron and steel plant. The coke produced in 1911 amounted to about 450,000 tons, nearly all of which was used in the manufacture of iron and steel at the company's plants.

The coal from Mines Nos. 1, 2, 3, 5, 12, and 14, is screened over ¾-in. screens and shipped from the mine over the company's railway, to the coal washery situated at the coke-oven plant. The coal is then washed and charged into the ovens.

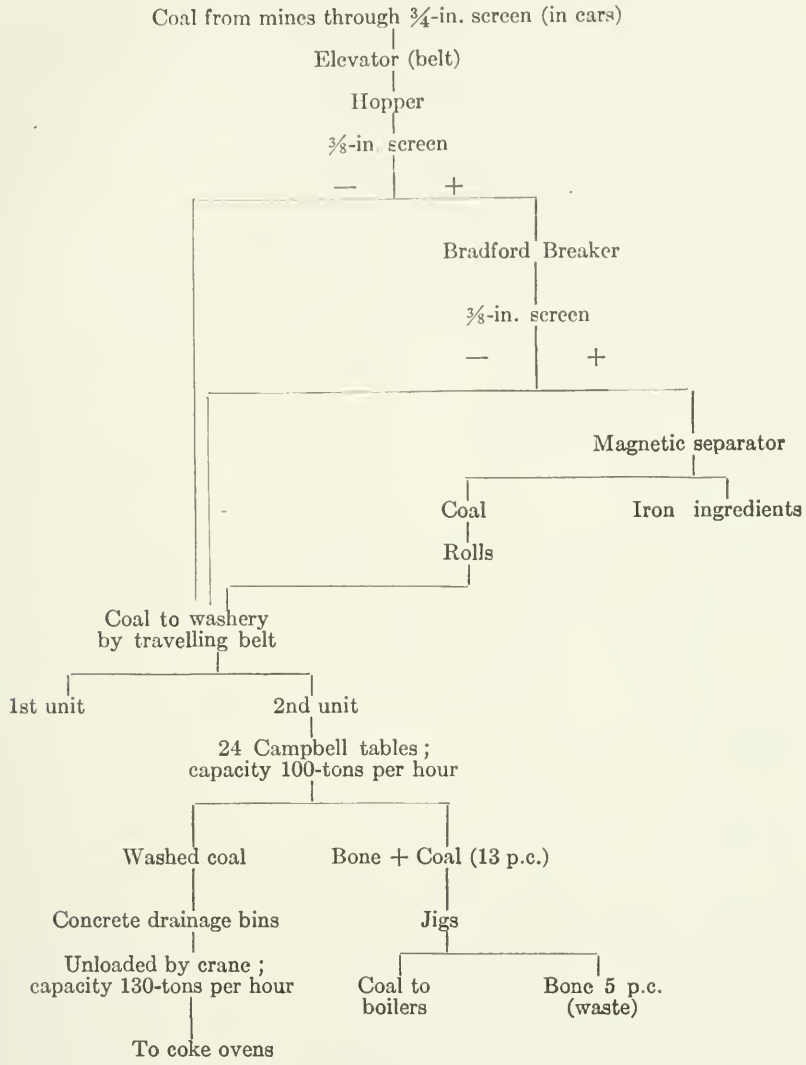
The following is an average analysis of the coal before washing :

Volatile	35.0 per cent
Fixed carbon	58.5 "
Ash	6.6. "
Sulphur	2.16 "

The washed coal has the following average analysis :

Volatile	36.0 per cent
Fixed carbon	59.0–60.0 per cent
Ash	4.09 "
Sulphur	1.67 "

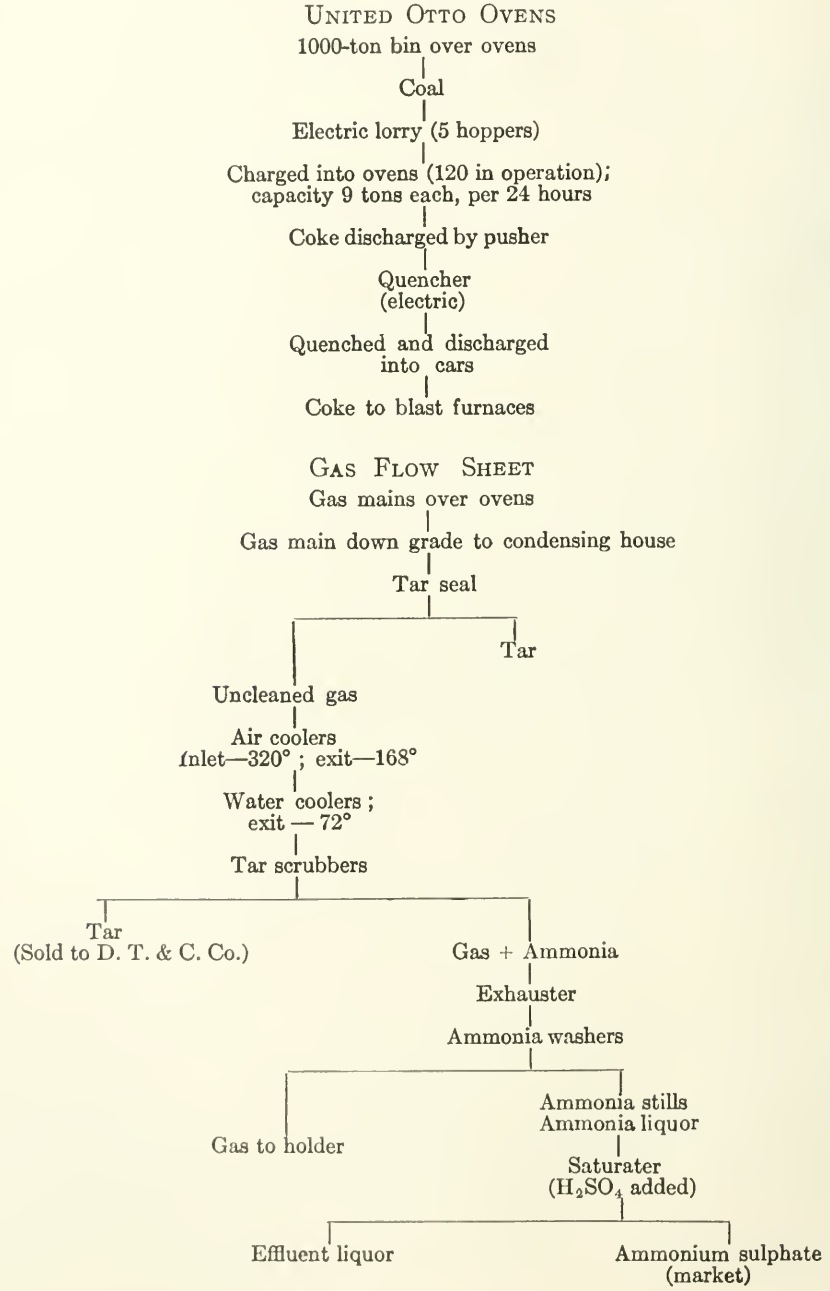
The following flow sheet shows the screening and washing operations :



Description of Coke Ovens.—The coke ovens are of the by-product type and consist of two separate installations. The old plant consists of 500 Otto Hoffmann ovens. These ovens are each 33 ft. long. 17 in. wide (without taper) and 6 ft. 3 in. high. They each have a capacity for a 5¼-ton charge; the coking period is 36 hours.

The new plant consists of 120 United Otto ovens. These ovens are 34 ft. long, 19 in. wide, tapering to 15 in. at the pusher end. They are 9 ft. 6 in. high and have a capacity for a 9-ton charge. The coking period is 24 hours.

The following diagrams show the method of charging and discharging the ovens and the gas flow sheet of the United Otto ovens.



The heating of the ovens is accomplished by the use of gas returned from the condensing house after the tar and ammonia have been removed. In the Otto Hoffmann ovens, there is a burner at each end of the oven, but only one burner for each oven is used at a time. The air for combustion is taken in at the end of the battery, where the gas and reversing valves are situated, and is led to the flues beneath the regenerative chambers. The regeneration chambers are filled with checker brick and extend the whole length of the oven battery. By means of the checker work, the air for combustion is heated up to about 1800° and passes through up-take connections to the space beneath the floor of the oven chambers and through lateral ports to the combustion chambers, where it meets the gas from the burner. The burning gases rise through the vertical flues of half the wall between the ovens, pass along the horizontal connecting flue above, and down the remaining vertical flues to the horizontal flue below, thence passing to the regenerator, where their heat is absorbed by the checker work; thence they are led to the lower regenerator flue, past the reversing valve, to the stack. On the reversal of the air and gas, the gas burner on the other end of the oven comes into use, the air passing up through the heated regenerator on that side and to the gas and combustion chamber, the heated gases passing in reverse direction through the wall flues downward through the regenerator and thence to the stack. The period of reversal is usually 30 minutes. The gas evolved from the coal is led from the oven through uptake pipes and valves to the gas-collecting mains and thence to the condensing house.

In the United Otto ovens, the gas is admitted from a burner at each end and from six burners situated beneath the ovens. The air for combustion is supplied to the regenerator by a fan.

The coal is charged into the ovens by means of a five-hopper, electrically driven lorry car. The coke is discharged and a new charge levelled by means of an electric pusher and leveller. The coke from the United Otto ovens is discharged into a coke quencher.

The coke quencher consists of a rectangular receiver, approximately of the same shape as an oven, and large enough to contain the coke charge. The top and bottom are tightly covered in with cast-iron plates, and the ends are provided with closely fitting doors. A cast-iron link conveyer, driven by a motor, runs on the bottom. The whole machine moves on rails parallel to the face of the oven battery and is operated by electric motors. When the coke charge has been pushed from the oven into the quencher the doors are closed and the quenching water is admitted. When the quenching is complete the door farthest from the ovens is opened and the coke is discharged

into the railroad car below by means of the conveyer situated in the bottom of the quencher.

By-products Recovered

Gas.—About 50 per cent of the gas obtained from the coal is used for heating the coke ovens. The balance, amounting to about 5000 cu. ft. per ton of coal charged, is used in the steel plant for burning lime for basic bessemer converters, for heating iron in the mixer, drying ladles, and for other purposes. Any surplus gas is used in the open hearth steel furnaces. The calorific value of the gas is about 500–550 B.T.U.

Tar.—The tar recovered amounts to about 9 imperial gallons per ton of coal charged into the ovens. The tar is sold to the Dominion Tar and Chemical Company, who distill it and get the various tar products, viz., pitch, light volatile oils, creosote and carbolic acid. Some of this pitch is now being used in Nova Scotia in the manufacture of coal briquettes. The tar is sold on a sliding scale and is worth from 2 cents to 3 cents per gallon.

Ammonium Sulphate.—The ammonium sulphate recovered amounts to about 23 lbs. per ton of coal charged into the ovens. It is guaranteed 24½-25 per cent NH_3, or equal to about 20.75 per cent nitrogen. It is sold in the United States and the West Indies, where it is used as a fertilizer on sugar plantations. The present value of ammonium sulphate is about $74.00 per ton.

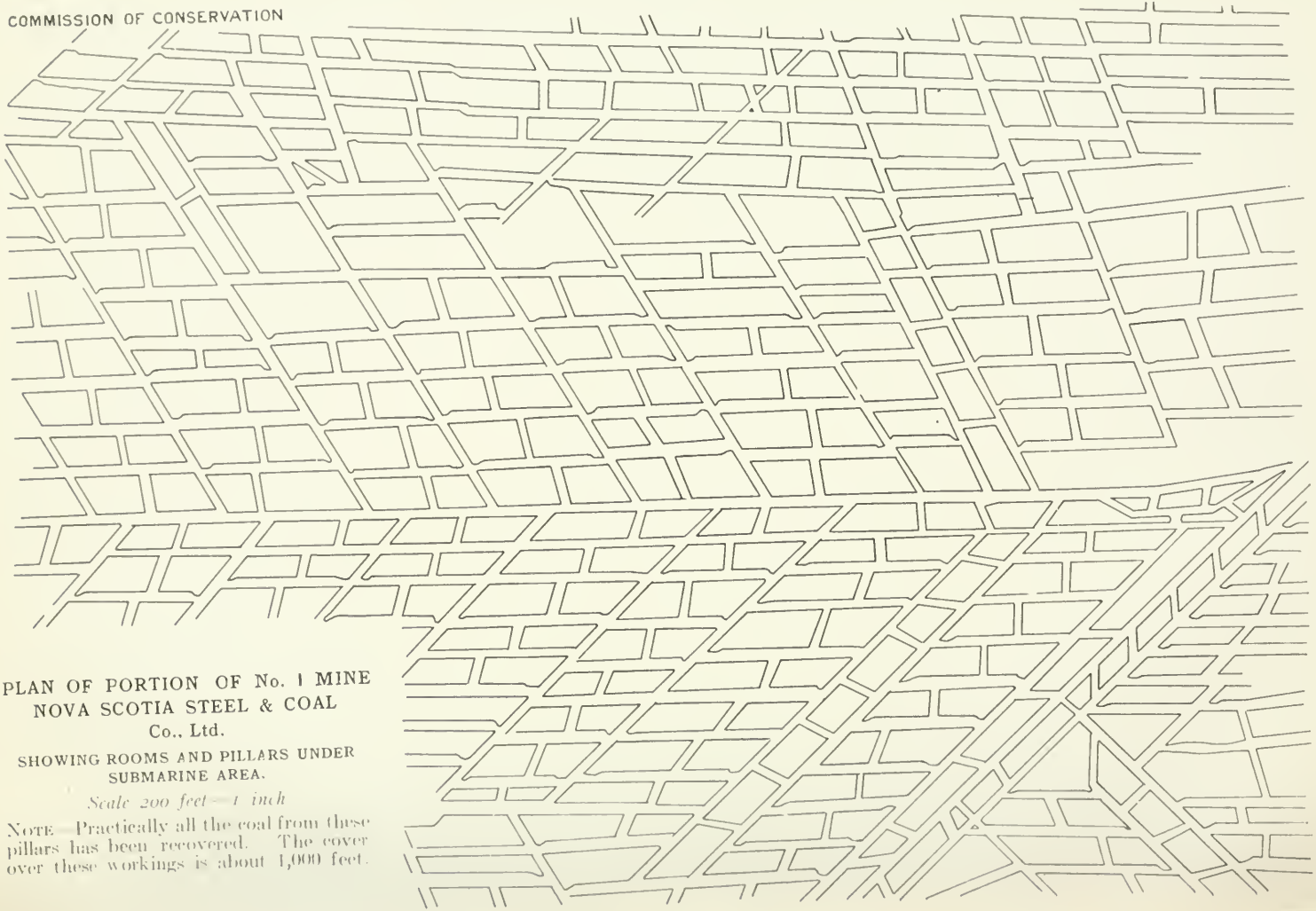
The sulphuric acid used in the manufacture of ammonium sulphate is manufactured near the coke ovens from Louisiana sulphur. About 96 per cent of the sulphur is recovered as sulphuric acid. About one ton of 60°Baumé acid is necessary in order to make one ton of ammonium sulphate.

Nova Scotia Steel and Coal Company

This company holds about seventy square miles of coal lands in the vicinity of Sydney Mines. This area comprises the land and submarine areas extending from the north side of Sydney harbour to the south side of the Great Bras D'Or lake, a distance of about ten miles, and an outer submarine area extending from cape Dauphin to cape Percy.

The table, page 39, shows the equivalency of the principal coal seams in the Sydney coal-field with the thickness of intervening strata in the several basins.

The Sydney Mines coal area was one of the earliest to be opened in Canada, work being begun on it in 1784. In 1828 it was purchased by the General Mining Association, who worked it until acquired by the Nova Scotia Steel and Coal Company, in 1900.



PLAN OF PORTION OF No. 1 MINE
NOVA SCOTIA STEEL & COAL
Co., Ltd.

SHOWING ROOMS AND PILLARS UNDER SUBMARINE AREA.

Scale 200 feet = 1 inch

NOTE.—Practically all the coal from these pillars has been recovered. The cover over these workings is about 1,000 feet.

The company operates the following collieries within this area :
No. 1, or Princess Colliery.
No. 2, or Lloyd Colliery.
No. 3, or Florence Colliery.
No. 4, or Scotia Colliery.
No. 5, or Queen Pit.

In 1911, these collieries produced 751,823 tons. The coal is shipped to the markets over the Intercolonial railway, or by water from the loading pier at North Sydney.

No. 1 or Princess Colliery

This mine is situated near Lloyd cove on the north side of Sydney harbour. It is worked by a shaft, 13 ft. in diameter, 680 ft. deep, sunk by the General Mining Association in 1868. During sinking operations, large quantities of salt were encountered at a depth of 300 ft. from the surface. This difficulty was overcome by lining the shaft with segments of cast iron, which remain intact to-day. A second shaft situated about 50 ft. distant is used for ventilation and to hoist men.

The coal seam worked is known as the Sydney Main. It is about 5½ ft. in thickness and dips at an angle of about 5° 13′ to the east ; consequently, most of the workings are under the sea. It is fairly regular and few faults and horsebacks are encountered in the mining operations. The roof consists of from a few inches to 10 ft. of shale, but the main roof is sandstone. The output of the mine is about 800 tons per day. There are 621 men employed underground and 168 above ground.

Haulage.—The coal seam is developed by two main haulage slopes, the north slope 1¾ mile long and the south slope, 2 miles long. There is trip haulage on the north slope and endless rope haulage on the south slope. There are six levels driven on each side of these slopes which extend to the boundary on each side, and also connect with No. 5 or Queen pit workings. The workings are very extensive, covering an area of about two thousand acres. The face of the workings is nearly two miles beyond the shore line and about 1,100 ft. beneath the sea-level. The haulage on the north slope is performed by a 16 by 30-in. geared engine installed on the surface, the haulage ropes being carried down the shaft. The endless-rope haulage engine for the south slope is also installed on the surface ; size of cylinders, 14 in. and 24 in. by 42-in stroke.

System of Mining.—The system of working used is room-and-pillar. Slants are driven off the levels every 130 feet ; the rooms are 16 ft. wide and are driven off the slants parallel to the strike. The pillars are 60 ft. thick with crosscuts every 60 feet. As soon as all the

rooms in a section are finished, the pillars are drawn, all of the pillar coal being recovered. In submarine work, no pillars are drawn with less than 800 ft. of cover.

The coal seam is soft and gaseous. With the exception of electric lights that have been installed at the pit bottom, Marsaut safety lamps are used exclusively underground.

Blasting Methods.—Station humidity reports are taken at several points on the intake and return airways. Some places are dry and sprinkling by tub is resorted to. The coal is mined by hand picks, while Bulldog powder and squib are used for blasting.

In timbering the mine, 3 lineal feet of props and booms are used per ton of coal mined.

Ventilation.—The mine is ventilated by a Capell fan, 20 ft. by 5½ ft., driven by a 120-h.p. direct current, 220-volt motor, geared with a 4.2 to 1 reduction, to the fan. The usual speed of the fan is about 100 revolutions a minute, its capacity 120,000 cu. ft. of air a minute, with a water gauge of 3 in. A Guibal fan of the same capacity, direct connected to a steam engine, has been installed as a spare fan in case of accident to the Capell fan.

Screening.—The coal is screened over a ¾in. bar screen, the oversize being picked by hand on a picking belt, and loaded into railway cars ; the undersize is screened over a ⅜in. screen. The oversize from this screen is crushed, mixed with the undersize and conveyed to a 500-ton capacity bin for unwashed slack. This slack coal is washed in coarse and fine Luhrig jigs. The washed slack is sent to the Bernard coke ovens, situated near the steel plant, or to the Bauer ovens near the coal washery. The overflow from the washery is settled in settling tanks, but a certain amount of the sludge is wasted and discharged into the sea.

Power Plant.—The power plant consists of six 275-h.p. water-tube boilers, three of which are fired with waste gases from a battery of 30 Bauer coke ovens. The gas is drawn from the ovens and passed through the boilers by means of induced and natural draft. The other boilers are fired with slack coal and coke breeze from the coke ovens. The company is now carrying on experiments with a mechanical chain-grate stoker for firing the boilers with fine slack. The coal is hoisted to the surface by means of ordinary cages placed in counter-balance. Each cage holds two cars having a capacity of 1500 lbs. of coal each. The main hoisting engine is driven by a pair of cylinders 36 in. by 60 in., the diameter of the drum being 18 ft. The man-hoist is of the same size, but is fitted with a pair of conical drums and equipped with regular and safety brakes. Compressed air for hoisting and pumping underground is supplied by a cross-compound Walker air compressor having a capacity

of 4000 cu. ft. of air per minute ; size of steam cylinders, 24 in. and 46 in.; air cylinders, 26 in. and 42 in.; stroke, 54 in. The mine is equipped with steam and air pumps for handling a capacity of 900 gals. per hour.

No. 2 or Lloyd Colliery

This colliery is on the Lloyd seam and is situated about 1000 feet north of No. 1 colliery. Four slopes, 7 ft. wide, have been driven from the outcrop, 1600 ft. from the shore line, for a distance of about one mile to the dip. As the dip of the coal seam is one in eleven, seaward, the face of the workings is about 4000 ft. from the shore line and 500 ft. beneath sea-level.

Of the four slopes, one slope is used as a return air-way, one for a pipe-line and travelling-road, while the two middle ones are used as the main haulage-ways for the empties and loads of the endless-rope haulage.

As the workings are submarine, and that the cover might be sufficient to keep out the sea water, the first level was driven both ways from the slope at 3400 ft. from the crop line. There are now three levels driven on the north and south side, the distance between levels being about 650 ft. This seam has an average thickness of about 6 ft. and is not badly disturbed by faults.

System of Mining.—The system of mining used is room-and-pillar. Headways, 8 ft. wide, are driven up the pitch from the levels every 300 ft. and rooms 1[illegible] ft. wide are driven at right angles to the headways. The pillars are 20 ft. wide and crosscuts are driven every 60 ft. Only advance work is being carried on as the cover is too thin to permit of drawing the pillars. The roof is a tender shale and the floor a soft fire clay. The coal is mined by 35 compressed air coal-cutting machines of the Hardy type. The compressed air for these machines is obtained from a compressor at No. 1 colliery, which has a capacity of 4,000 cu. ft. The power plant and haulage engine are also situated at No. 1 mine.

Blasting.—Bulldog powder and squibs are used for blasting. Station humidity reports are made at different points in the intake and return airways, but, as the mine is damp, no sprinkling is required.

Ventilation and Lighting.—The haulage road is used as an intake and the ventilating current is split at the bottom of the slope, one current ventilating the north side, the other ventilating the south side of the mine. The mine is ventilated by a Capell fan, 15 ft. by 10 ft., capacity 150,000 cu. ft. a minute, driven by a duplex 9 in. by 9 in. steam engine. Marsaut safety lamps are used exclusively underground.

Timbering.—The system of timbering is props-with-caps, and, sometimes, props-and-booms depending on the condition of the roof.

In timbering the mine, .57 lineal feet of props and booms are used per ton of coal mined.

About 297 men are employed underground and 38 above ground. The output averages about 500 tons per day.

Screening.—The bankhead is of wooden construction and is situated about 2000 ft. from the slope mouth. The endless rope haulage, delivers the coal to the bankhead in one-ton mine cars, where it is screened over a 2-in. bar screen and a ¾-in. square-mesh, knocking screen. It is then loaded into 15-ton hopper-bottom railway cars. The large sized coal is, however, first picked on a picking belt.

No. 3 or Florence Colliery

This colliery is situated near Big pond on a branch of the company's railway 2½ miles from No. 1 Colliery and five miles from the shipping pier at North Sydney.

The coal seam worked is Sydney Main, average thickness 4 ft. 9 in. and dips one in eleven to the eastward. The mine is developed by three slopes driven from the outcrop 8800 ft. to the dip. One slope is used for main endless-rope haulage, one for a travelling road and the other for a return air-way. There are in operation seven levels, driven from the main slope on the south side, and two on the north side. The mine has a capacity of 1000 tons per day, but the actual average is about 900 tons. There are 473 men employed underground and 101 above ground.

System of Mining.—The system of mining used is bord-and-pillar, the rooms being 20 ft. wide and 300 ft. in length, and the pillars from 35 ft. to 40 ft. thick ; crosscuts are driven every 60 ft. Owing to the workings being largely submarine, and as the cover is not great, no pillars have been drawn. The coal is mined by compressed air coal-cutting machines of the puncher type. There are 40 of these in the mine. All machine cuttings are loaded out before blasting.

Blasting Methods.—Bulldog powder and squib and Monobel and battery are used for blasting. The mine is dry in parts and water tubs with sprays are used for sprinkling.

In timbering the mine .75 lineal feet of props and booms are used per ton of coal mined.

Ventilating and Lighting.—The mine is ventilated by a Capell fan, 15 ft. by 7½ ft., direct connected to a tandem, compound steam engine. It delivers 48,900 cu. ft. of air per minute, the water gauge being 2.2 in. A 10 ft. by 6 ft. Murphy ventilator is installed as a spare fan. Marsaut safety lamps are used exclusively underground.

Power Plant.—The power plant consists of six 250-h.p. water-tube boilers which burn slack coal and coke-breeze. The draft is induced by means of a Sheldon fan.

Screening.—The bankhead is equipped with two rotary tipples and the coal is screened over 1½-in. bar and ½-in. shaking screens. The coal which passes over the 1½-in. bar screen is picked over a picking belt and loaded into cars. A portion of the slack coal is burned under the boiler to produce steam, the remainder is loaded into cars and sent to the washery plant at No. 1 Colliery.

Haulage.—Endless-rope haulage on single tracks is used on all levels except No. 2, which is operated by horse haulage. The main endless-rope haulage is operated by a tandem compound engine ; size of cylinders 14 in. by 24 in., with a 42-in. stroke

A compound steam engine, size of cylinders 14 in. and 24 in. by 42-in. stroke is used for operating the main endless rope haulage on the slope.

Compressed air for operating the coal cutters, mine haulage and pumping is furnished by a cross-compound Norwalk air compressor, capacity 3500 cu. ft. of air per minute and a Walker air compressor, capacity 3000 cu. ft.

No. 4 or Scotia Colliery

This mine is situated about two miles to the northwest of No. 3 Colliery, and is seven miles distant from the shipping pier at North Sydney. A branch railway connects it with the other lines of the company's system. The seam worked is the Sydney Main, which has, at this point, an average thickness of 4 ft., and a dip of one in eleven to the eastward. The mine is developed by three slopes driven from the outcrop 4000 ft. to the dip. The middle slope, which is 12 ft. in width, is used as a main haulage slope ; while two outside slopes, which are each 10 ft. wide, are used as travelling roads, and for ventilating purposes. The slopes are separated from one another by pillars 25 ft. thick. The mine has a capacity of 600 tons per day, but the actual average is about 500 tons. There are 376 men employed underground and 76 above ground.

System of Mining.—The system of mining used is bord-and-pillar. Levels are driven both ways from the main slope every 500 ft., and headways are driven up the pitch from the levels, 250 ft. to 300 ft. apart. From the headways rooms are broken off and driven parallel to the levels. The rooms are 20 ft. wide and the pillars are each 20 ft. thick. The cover varies in depth from zero at the outcrop, to 270 ft. at the bottom of the slope. As soon as the rooms in a level are nearly finished, the pillars are drawn by commencing at the slope

side and advancing towards those rooms which are almost completed at the end of the level. These latter pillars are recovered by means of headways, which are driven from the next lift. Headways and levels are driven 14 ft. wide and timbered with ordinary booms and props.

The coal is mined by electric coal cutters of the puncher and long-wall chain types. Blasting is done with Bulldog powder and squibs and Monobel and battery. The mine is naturally damp and no sprinkling is resorted to. In timbering the mine, 3½ lineal feet of props and booms are used per ton of coal mined.

Haulage.—As the mine is free from gas and naturally damp, all the haulage and pumping is performed by electric hoists and motors ; a practice that would be unjustifiable in mines where such conditions do not exist. Plane haulage is used on the main slope, the mine cars being hoisted to the surface in rakes of 20 cars. The pit tubs or mine cars are pushed by hand to the headways, the cars are then lowered to the standage on the level at the bottom of the headways, by means of 11 h.p. motor-driven electric hoists. The empty cars are hoisted from the level, to rooms on the headway, by means of the same hoists. Haulage on the levels is by single track endless-rope haulage, operated by a 22-h.p. electric motor which, generally, serves three headways. Direct current is used on all motors, at 240 to 250 volts. The main haulage is driven by second-motion double drum hoist ; size of cylinders 16 in. by 24 in. stroke ; drum 6 ft. in diameter.

Ventilation and Lighting.—The mine is ventilated by a 54-in by 60 in. Sirocco fan having a capacity of 150,000 cu. ft. a minute with 5-in. water gauge. This fan is belt driven from a steam engine 14 in. cylinder diameter, by 12 in. stroke, and delivers 54,322 cu. ft. of air per minute with a water gauge of $1^3/_7$ in. Marsaut safety lamps. are used exclusively underground.

Screening.—The coal is hauled out of the slope in mine cars and lowered down on a trestle, making an angle of about 60° with the direction of the slope, to the screening plant, where the coal is dumped on a 1-in. bar screen by means of a revolving tippler. The oversize is picked on a picking belt, 5 ft. wide by 43 ft. long, and discharged into 15-ton hopper bottom railway cars. The slack coal falls into a slack-hopper and is conveyed by a cross belt which discharges into railway cars.

Power Plant.—The power plant consists of four 75-h.p. return tubular boilers. This plant furnishes steam for the main haulage engine, fan engine, and electric generators. Electric energy for lighting, pumping, coal-cutting and mine haulage is supplied by two 100-k.w. direct current generators direct driven from 15 in. by 16-in. steam

PLAN OF No. 4 MINE, NOVA SCOTIA STEEL & COAL Co., L'd.
Scale 400 feet = 1 inch

engines. The plant is also equipped with the necessary blacksmith and machine shops for doing ordinary mine repair work.

No. 5 or Queen Pit

This is an old colliery which was formerly worked by the General Mining Association and was recently re-opened by the Nova Scotia Steel and Coal Co. Prior to 1854, the coal was worked from an area extending to the rise of what was afterwards the Queen pit workings, from what was known as the "B" pit, but, owing to a heavy influx of water which overpowered the pumping engine, it was abandoned, and the Queen pit was brought into operation. This shaft is sunk on the Sydney Main seam, and has a depth of 360 ft. The seam dips one in eleven to the east and averages 5½ ft. in thickness. The dip workings in this mine connect with No. 1 Mine. It has a capacity of 500 tons per day, but the actual average output is about 450 tons.

System of Mining.—The mine is developed by means of a main level, which has been driven for a distance of half a mile to the north and south of the shaft. It is operated by endless-rope haulage and the workings are to the rise and dip of this level. The system of mining used is bord-and-pillar. The rooms are 18 ft. in width, and the pillars are from 18 ft. to 24 ft. in thickness. As all the rooms in this area have been driven, the pillars are now being removed, thus recovering a large percentage of them. In timbering the mine, 4 lineal feet of props and booms are used per ton of coal mined. Station humidity reports are made at different points on the intake and return air-ways. The coal is hoisted to the surface by means of an ordinary cage. The mine cars are 850 lbs. in weight and have a capacity of 1500 lbs. of coal.

Ventilation and Lighting.—The mine is ventilated by the return air from No. 1 Colliery, the fan being installed at No. 5 shaft. Marsaut safety lamps are used exclusively underground.

Screening.—The coal is screened on the bankhead, over a pair of 2-in. and ¾-in. shaking screens. The upper screen is also furnished with blank plates for making run-of-mine. The screened and nut coal is picked over picking belts before being discharged into railway cars.

Power Plant.—The power plant consists of three 50-h.p. return tubular boilers, and the endless-rope haulage is operated by a 75-h.p. direct current motor. The hoisting in the main shaft is done by a direct connected steam engine; size of cylinders, 14 in. by 36-in. stroke. The bankhead machinery is driven by a 35-h.p. 240-volt, direct-current motor.

Briquetting Plant, Mackay Mine

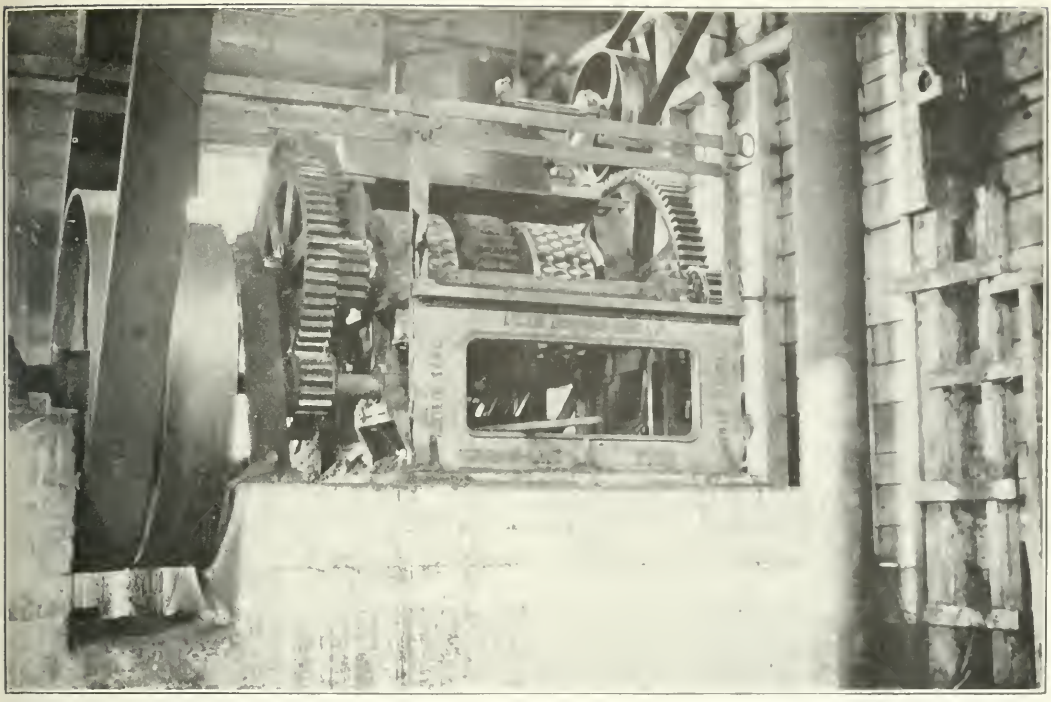
On account of the friable nature of the coal mined at the Mackay Mine, much slack is made. As there is little or no market for this, the management have installed a briquetting plant, the first for briquetting bituminous coal, that has been installed in Canada. The same company has also installed two similar units at the Colonial Mine, which produce 175 tons of briquettes per day. The briquetting plants are of Belgian manufacture and are of the roll press type.

The briquettes, which are oval in shape, are manufactured from a mixture of coal and pitch, which is run through rolls. When they come from the rolls they are usually soft, but harden upon cooling, and withstand handling very well. The pitch, used as a 'binder,' forms from 6 to 8 per cent of the mixture, by weight, and is one of the by-products obtained from the tar, recovered at the Dominion Iron and Steel Company's coke-oven plants. The briquettes have been used with considerable success upon the Intercolonial railway, and also for domestic purposes. The Mackay mine plant, diagrammatically outlined on page 79, has a capacity of 10 tons of briquettes per hour. The plant is housed in a building 45 feet by 33 feet and 25 feet high. The machinery is driven by a 75 h.p. motor.

Method of Manufacture.—The coal from the mine is screened over a ¾-in. screen; the lump coal, which is ¾-in. or more, in diameter, is sent to market, and the fine coal is carried by a disc elevator to a 75-ton bin. From the bin the coal is discharged by chute into a 10-ton concrete pocket situated at the briquetting plant and is then elevated by a bucket elevator to a 3-ton cone hopper; by means of a revolving table and a plough-shaped cutter, situated at the bottom of the hopper, it is fed from the hopper to the disintegrater at any desired rate of speed.

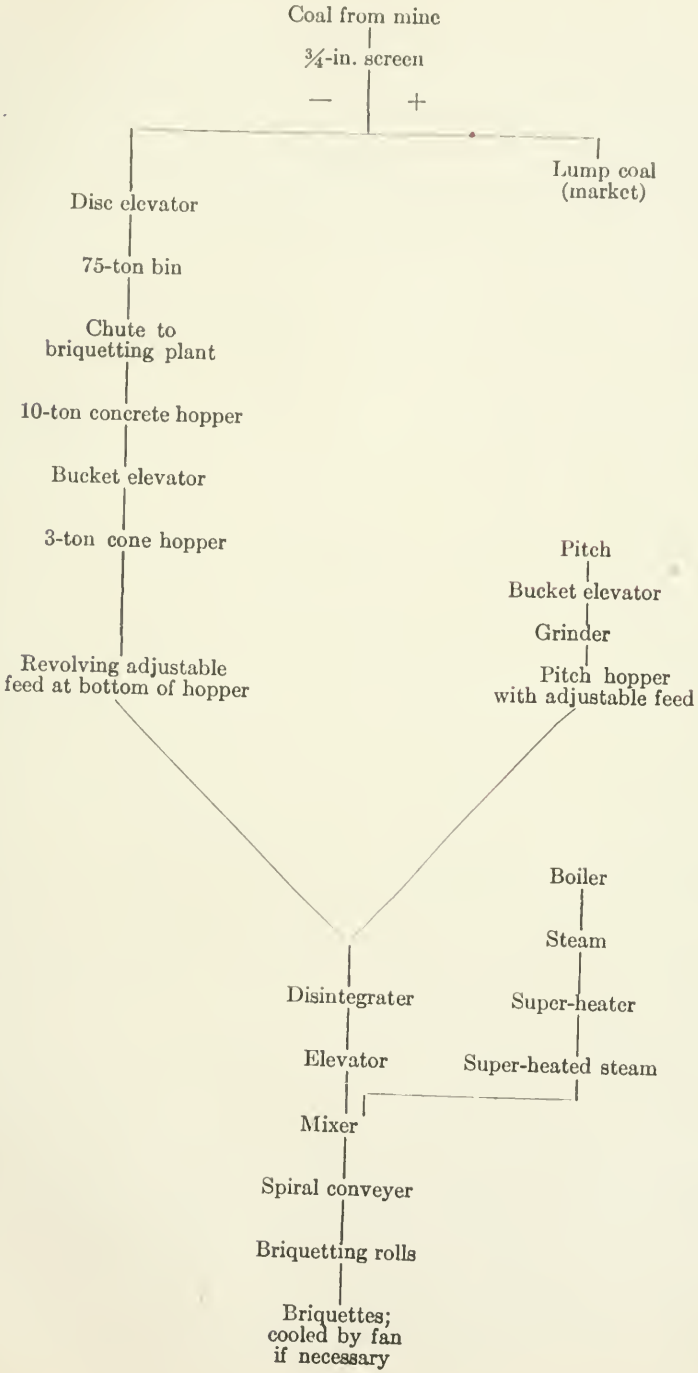
After crushing, the pitch is fed into the disintegrater by means of an adjustable feed, similar in type to the one used for the coal. From the disintegrater, the coal and pitch are elevated to the mixer where super-heated steam is introduced. The heated coal is then conveyed to the roll press by means of a spiral conveyer.

The following diagram shows the arrangement of the plant :



Briquetting Rolls, MacKay Mine, N. Sydney, N.S.

Briquetting Plant and Storage Bins, MacKay Mine, North Sydney, N.S.


Coal from mine
¾-in. screen
—
+
Lump coal (market)
Disc elevator
75-ton bin
Chute to briquetting plant
10-ton concrete hopper
Bucket elevator
3-ton cone hopper
Revolving adjustable feed at bottom of hopper
Pitch
Bucket elevator
Grinder
Pitch hopper with adjustable feed
Boiler
Steam
Super-heater
Super-heated steam
Disintegrater
Elevator
Mixer
Spiral conveyer
Briquetting rolls
Briquettes; cooled by fan if necessary

Inverness Mine

This mine is situated at Inverness, a town on the west shore of Cape Breton. The mine is owned and operated by the Inverness Railway and Coal company. As Inverness harbour is unsuitable for a shipping port, all water shipments are made from Port Hastings, about 60 miles distant. Rail shipments are made by means of the Inverness railway which connects with the Intercolonial railway at Point Tupper.

The seam worked is known as the Seven-foot seam, and the coal averages seven feet in thickness. The dip varies from 15½° at the surface, to 43° at the bottom level ; the direction of dip is N. 7° E. In addition to the seven-foot seam, there is a 13-foot seam of coal, which is situated about 270 ft. above the seam, and is not being worked. The coal in this second seam is not all clean. As the pillars are being drawn from the lower seam, it is doubtful if the upper can be subsequently worked over the same area.

The mine was first opened up by a main haulage slope, 3600 ft. in length, driven from the outcrop on the full dip of the seam. As the dip increased to 40°, an angle slope was started off the main slope about 400 ft. from the surface, and driven at an angle of about 45° to the direction of dip, for a distance of about 5600 ft.

System of Mining.—The system of mining used is bord-and-pillar. Pillars 150 ft. in width are left on each side of the slope to protect the main slope. Levels are driven in double entry for nearly one mile to the east and west of the main slope in such a manner as to leave 500 ft. of coal between them. Pillars from 35 to 50 ft. wide are left between the main and counter levels ; the upper level being the haulage road. Headways in triple entry are driven up the pitch from the levels every 600 ft. Rooms from 17 to 12 ft. wide, depending upon the amount of cover, are opened off from a pair of headways every 47 ft., centre to centre, and are driven to meet each other. There are ten working places in a headway.

When the dip does not exceed 25°, back balances are used in the headways ; on steeper dips, chutes are used. The upper rooms are kept in advance of the lower, and, as soon as the upper five rooms have been driven 300 ft., the pillars are drawn back towards the heading. In drawing pillars, the face of the upper pillar is always kept 20 ft. in advance of the next lower pillar. As soon as the top half of a balance is finished the rooms in the lower half are driven and the pillars extracted. The pillars are drawn to within two rows of pillars from the level. These level pillars will be recovered as soon as a level is completely worked out. Five lineal feet of timber are used per ton of coal

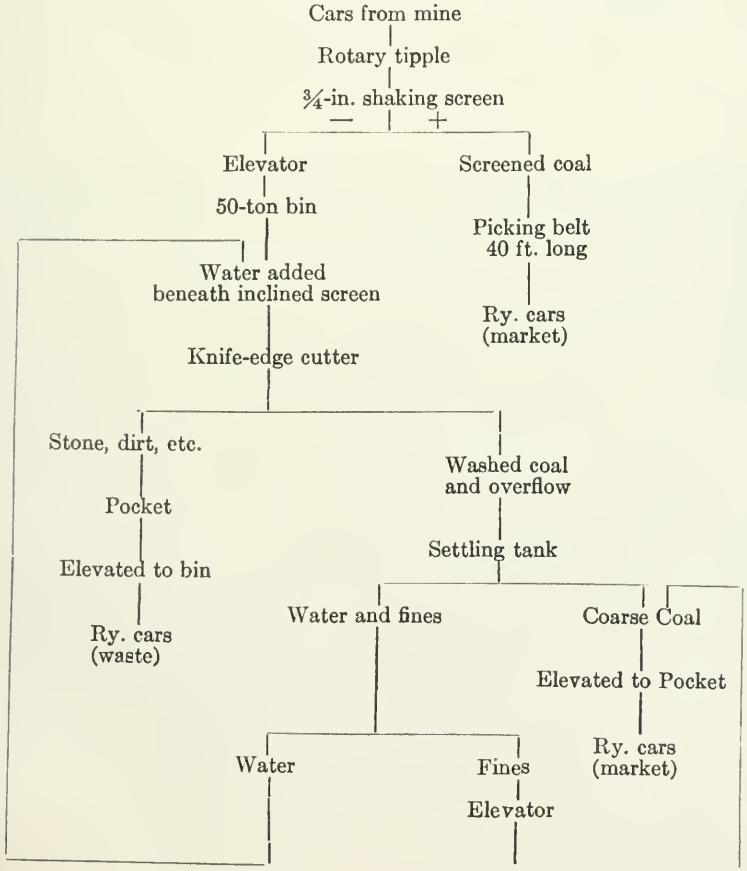
mined and loose black powder and squibs are used for blasting. The mine has an average output of about 1000 tons of coal per day.

The cover over the workings varies in depth from zero to over 1,220 ft. A considerable portion of the workings of this mine is under the sea ; some of them extending to a distance of half a mile beyond the shore-line. Under the land area pillars are not drawn out where the cover is less than 350 feet in depth, and submarine pillars are only removed where the cover exceeds 550 feet. The immediate roof over the coal consist of from 2 ft. to 10 ft. of shale ; above this, is about 40 ft. of sandstone, and about two-thirds of the remainder of the strata consists of shale. The pavement is shale.

Haulage.—Horses are used for haulage on the main levels. The coal is hauled up the main slope by means of a second motion hoisting engine situated on the surface, in trips of ten cars of a capacity of one ton each.

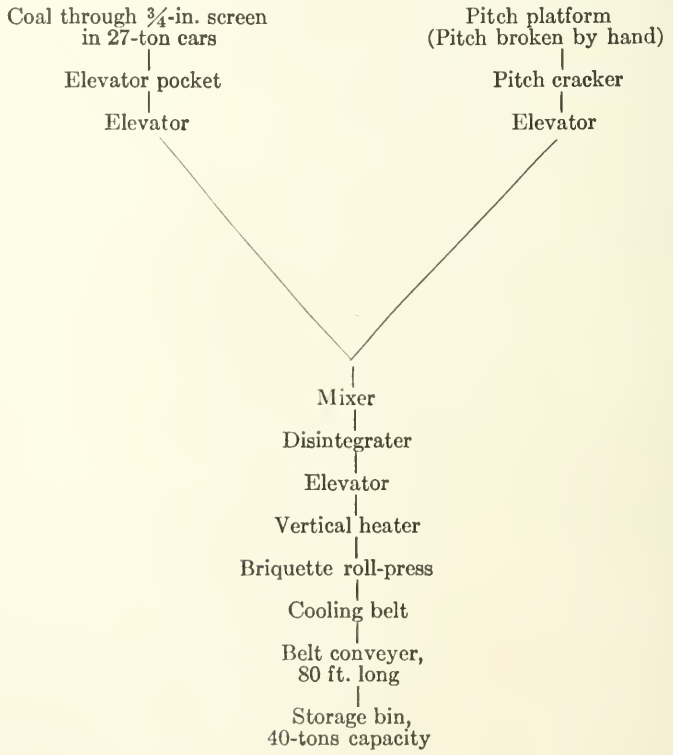
The accompanying diagram shows the screening and washing operations used at this mine.

Schedule of Screening and Washing Operations



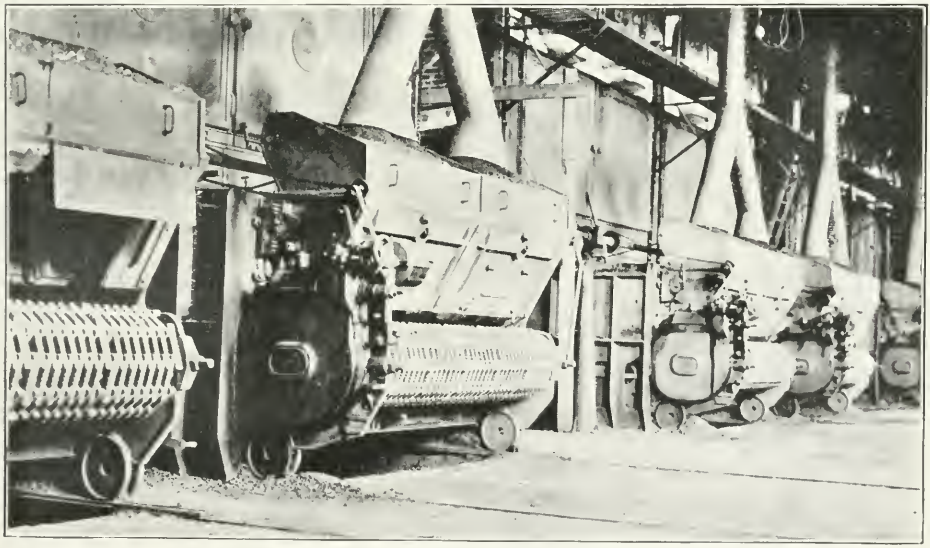
Owing to the large amount of slack coal made during mining operations, the company have installed a coal-briquetting plant, with a capacity of 10 tons of ovoid briquettes per hour. The briquetting plant is situated about a quarter of a mile from the mine, and the coal is delivered there, from the screening plant, by means of 27-ton hopper-bottom railway cars. The diagram also gives an outline of the briquetting process installed at this mine. The binder used is pitch recovered from by-product coke ovens, and is obtained from the Dominion Tar and Chemical Co., Sydney. The percentage of pitch necessary to give firm briquettes is estimated at from 5 per cent to 8 per cent of the weight of coal used.

Outline of Briquetting Plant



Boiler Plant.—The boiler plant consists of four 212-h.p. and two 250-h.p. water-tube boilers. Two 15-h.p. and one 35-h.p., vertical boilers, are installed, but are not in use.

Power House and Bankhead, Allan Shafts, Acadia Coal Co.



Chain-grate Stokers, Allan Shafts, Acadia Coal Co., Stellarton, N.S.

Surface Machinery.—The surface machinery consists of :

One second motion, double drum, main-slope hoisting engine, geared 3 to 1; size of cylinders 16½ in. by 30 in.; diameter of drums 7 ft., each containing 5500 ft. of 1⅛-in. plough steel rope.

One second motion hoisting engine for travelling slope ; size of cylinders 12 in. by 16 in.; geared 7 to 30 ; diameter of drum, 4 ft.

One 20-h.p. hoist for disposing of mine waste.

One 12 in. by 12 in. Robb engine, direct connected to a 50-k.w. generator for lighting purposes.

One two-stage, 3100 cu. ft. capacity, cross compound, steam air compressor which furnishes power for mine haulage and pumping purposes.

Underground Machinery.—The underground machinery consists of compressed air hoists for sinking purposes, and the necessary compressed air and steam pumps for removing the mine water. The average daily pumpage is 432,000 gals.

Ventilation and Lighting.—The mine is ventilated by an 18 ft. by 7 ft. Walker fan which is rope driven from a 16 in. by 30 in. simple steam engine. The fan delivers 110,000 cu. ft. of air per minute with a water gauge of 2.8 in. The air is split at the lowest level, one split going to each side of the slope. Marsaut safety lamps are used exclusively underground. The plant is also equipped with the necessary pumps for fire-fighting purposes.

Acadia Coal Company

This company owns and operates four collieries in the Pictou coalfield, and controls an area of 16 square miles, in which are situated the Albion colliery, the Allan Shaft, the Vale Colliery, and the Acadia Colliery.

Albion Colliery

This colliery is situated one and one-eighth mile from Stellarton, a town on the Intercolonial railway, to which it is connected by means of a short railway.

The following is an approximate section of the measures, showing the position of the coal seams :

Foord seam	28 feet
Strata	220 "
Four-foot seam	4 "
Strata	6 "
Cage-pit seam	16 "

Strata	150 feet
Third seam	14 "
Strata	80 "
Fleming seam	3½ to 4 "
Strata	5 "
McGregor	8 to 9 "

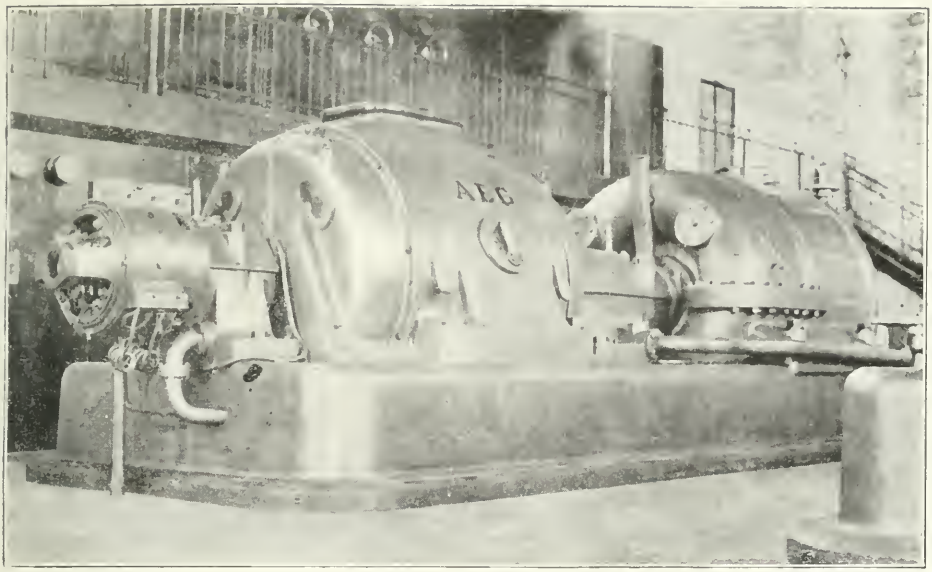
At this colliery, four seams are worked—the Foord, Four-foot, Cage-pit, and Third. These seams are developed from a slope 5,200 feet in length driven on the dip of the Third seam. At No. 5 level, in the Third seam, 2,800 feet from the surface, a tunnel is driven to cut the Cage-pit, Four-foot, and Foord seams, all the coal from the latter being delivered at No. 5 level and hoisted up the main slope. The average dip on the main slope is about 22°. The system of mining used is bord-and-pillar in the Third, Cage-pit, and Foord seams ; but it is probable that the Four-foot and Fleming seams will be worked by the longwall method.

System of Mining.—Levels 9 ft. wide are driven off the main slope every 700 feet and balances are driven up the pitch from the levels every 800 feet. The rooms are 7½ ft. high and 12 ft. wide and the pillars are 47 ft. wide ; crosscuts are driven through the pillars as far apart as possible. In the Third and Cage-pit seams not much development work is being done, but some balances have been opened for pillar work.

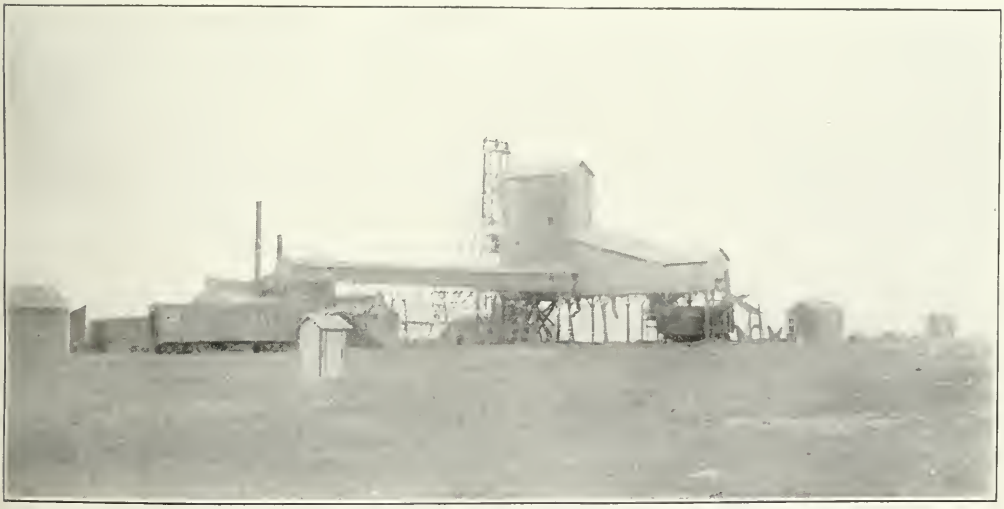
The levels are driven to the boundary, and, as soon as all the rooms are finished, the pillars are drawn in retreating order and the level closed up. The top entry is the haulage level, and the bottom serves as a return for the next lift. Where a pillar face is lost through a fall, a room about 8 to 9 ft. wide is driven parallel to the pillar face, and about 6 ft. from it. The roof is then held on timbers, and the face is regained by commencing at the top and breasting back the six-foot pillar between the room and the fall. The upper pillars are each drawn a little in advance of the next pillar lower down. While only 7½ ft. of coal is obtained in the room workings, 12 ft. is obtained in pillar work. Three to four feet of unsaleable coal is left in as a floor. The roof and pavement are composed of shale and impure fire clay.

Mining is generally done with hand picks, but coal cutters of puncher and radial types are also used.

Blasting Methods.—Monobel and battery are used for blasting in coal, while Saxonite is used for rock. The tamping material used is clay, which is sent into the mine for that purpose. The mine is fairly damp and has no sprinkling system. No systematic hydrometer readings or records are kept. The average output is about 525 tons of



Steam-turbo Generators, Allan Shafts, Acadia Coal Co., Stellarton, N.S.



Bankhead, Manitoba-Saskatchewan Coal Co., Bienfait, Sask.

coal per day. There are 180 men employed underground, and about 80 above ground.

Power Plant.—This mine is supplied by electric power from the central station, situated at the Allan shafts. The power is brought to the mine by two underground cables each containing three conductors, three phase current, at 3150 volts.

The hoisting engine at the main slope is a 320-h.p. electric hoist, speed 600 ft. per minute ; voltage, 3,100.

Two air compressors, which have a capacity of 1,600 cu. ft. of air per minute, and which are driven by a 320-h.p. motor, furnish power to the Albion and McGregor mines for underground haulage, coal cutting, and pumping. The voltage on motor is 3,100 and the amperage, at full load, 50. The speed of the motor is 500 r.p.m. and the air compressor 120. The air is compressed in two stages; first stage to 25 lbs. per square inch, second stage to 100 lbs.

Ventilation and Lighting.—The mine is ventilated by a Walker fan delivering 60,000 cu. ft. of air per minute. This fan has been replaced by an electric driven Capell fan having a capacity of 100,000 cu. ft. of air per minute. Wolf safety lamps are used exclusively underground.

The water in this colliery is conveyed from one seam to the other by a series of bore-holes ; finally reaching the McGregor seam, it is raised to the surface by a pump with cylinders 16 in. and 26 in. and a 24-in. stroke.

Screening.—The coal is screened over a 2¼-in. by 1-in. rocker and ¾-in. screens, and loaded direct into railway cars.

The bankhead machinery is driven by two 45 h.p., three 25 h.p., and five 10 h.p. electric motors.

McGregor Mine

This mine is situated a short distance from the Albion Mine and the coal from it is screened over the same bankhead.

The following is a section of the McGregor seam :

Fleming seam	3–4 feet thick
Stone	4 " "
McGregor seam	8–10 " "

The McGregor seam is worked by means of a slope about 5,000 ft. long, which has recently been cleaned and re-timbered. There are seven levels on the east side and six on the west; the distance between the levels being about 500 to 600 ft. In No. 2, No. 3 and No. 4 levels, there is a large quantity of coal, but the writer is informed that, on account of the small pillars left on the east side of the slope, it is not

possible successfully to extract these pillars ; on the west side, the coal on No. 2 and on No. 3 level is of poor quality and is unsaleable. No. 5 and No. 6 levels on the east side have been cleaned up and some bords are in operation on them. This district has not been opened up since it was flooded after the fire in 1906. Pillars are now being drawn on No. 4 and No. 5 levels, west side.

Mechanical Equipment.—All the power for this mine is supplied by electricity from the central power plant situated at the Allan shaft. To pump the water from the McGregor and Albion mines, two electric centrifugal pumps with a capacity of 550 gals. per minute each, have been installed at the bottom of the slope. An electric-driven Capell fan with a capacity of 100,000 cu. ft. of air per minute has been installed for ventilating the mine. The hoisting is done by a 320-h.p. electric hoist. The bankhead is connected by car-hauls with the Albion bankhead where the coal is screened over 2¼-in. by 1-in. and ¾-in. screens and loaded direct into railway cars.

The coal is shipped to the markets by the Intercolonial railway and also by rail to Pictou Landing, whence it is carried by boats to Montreal and other points.

Acadia Mine

This mine is situated at Westville, three miles from Stellarton, a town on the Intercolonial railway. The upper, or Acadia Main seam, is the only seam worked from this colliery. The average thickness is 16 ft.; the angle of dip varies from 22½° at the surface to 26° at the bottom levels ; small faults are frequently met with in the workings. The main slope is driven on the dip and is about 5000 feet in length. The width of this slope varies from 10 ft., near the surface, to 8 ft. at the bottom. The mine has a capacity of 350 tons per day, but the actual average is about 300. There are 220 men employed underground and about 70 above ground. About ten lineal feet of timber are used per ton of coal mined.

Method of Mining.—Levels have been driven on each side of the slope every 300 feet, there being 12 levels in all. The maximum cover over No. 12 level is about 2,300 feet. Owing to the thickness of the seam and the great weight of the superincumbent strata the method of working is similar to that in use at the Drummond mine. (See diagram and description, pages 88,90.) From No. 3 level down, only 7 ft. 3 in. of the top coal has been recovered and the company is now mining the bottom coal in No. 5 and No. 6 levels. The method employed is similar to that in use at the Drummond mine.

Haulage.—Direct haulage is used on the slopes, and horse haulage on the levels. The track gauge is 2 ft. 4 in., and the mine cars have a capacity of nearly 1,800 lbs.

Blasting Methods.—In mining the top coal, shooting is not allowed but Monobel and battery are used for shooting the bottom coal. The mine is fairly dry and dusty and the levels are sprinkled about twice a week. The roof is grey slate and the pavement a soft, impure fire clay.

Ventilation and Lighting.—The mine is ventilated by a rope-driven Capell fan delivering 26,500 cu. feet of air per minute. The main slope is the main intake and the air is split at the bottom of the slope, one portion going to the north side and the remainder to the south. Wolf safety lamps are used exclusively underground. The water is pumped from the bottom to the surface in four lifts; average daily pumpage is about 275,000 gals.

Mechanical Equipment.—The boiler plant consists of five 150-h.p. water tube boilers. The main hoisting engine is 32 in. by 60-in. stroke, drum 10 ft. The hoist rope is 1⅛ in. in diameter. The man hoist is 12 in. by 12 in. ; drum 4 ft. 8 in., rope ¾ in. in diameter. The fan engine is 9 in. by 16 in.

Power for mine haulage and pumping is supplied by two air compressors ; the air cylinders are 20 in. and 24 in. in diameter ; steam cylinders 24 in. and 30 in. by 36-in. stroke. The mine is also equipped with blacksmith, machine, and carpenter shops for doing ordinary mine repair work.

Screening.—The coal is screened on a wooden bankhead equipped with shaker screens for separating the coal into lump, egg, nut and culm. The culm is burned under the boilers to produce power.

Allan Shafts

This colliery is situated at the north end of the town of Stellarton, and about 1100 ft. from the old Foord pit shaft, which was abandoned in 1880 on account of an explosion. It is worked by two shafts, No. 1 and No. 2, each 32 ft. by 11 ft. inside of timber. The Allan shafts were sunk for the purpose of cutting all the seams in the basin. No. 1 shaft encountered the Foord seam at about 1200 ft., and the Cage-pit at 1428 ft. from the surface. This shaft is now filled with water up to the 1200-foot level. No. 2 shaft was sunk 350 ft. distant from No. 1, and encountered the Cage-pit seam at 962 ft. from the surface. The shafts are connected for ventilation by a stone drift driven from the 962-foot level, No. 1 shaft being the intake and No. 2 the return. The air is split at

the bottom of No. 1 shaft ; one split ventilates the Cage-pit seam, by means of the stone drift connection while the other ventilates the workings to the rise of the 1200-foot level in the Foord seam, and returns to No. 2 shaft, by means of a connection driven from No. 2 shaft to the Foord seam. Only the last-named seam is being worked. The thickness varies from 37 ft. to 45 ft. and the dip from 10° to 60°.

System of Mining.—The systems of mining the coal used are bord-and-pillar and double bord-and-pillar. Bords are 12 ft. to 14 ft. wide, and from 8 ft. to 9 ft. high. The pillars are never less than 50 ft. wide. There are 110 men employed underground and 50 above ground.

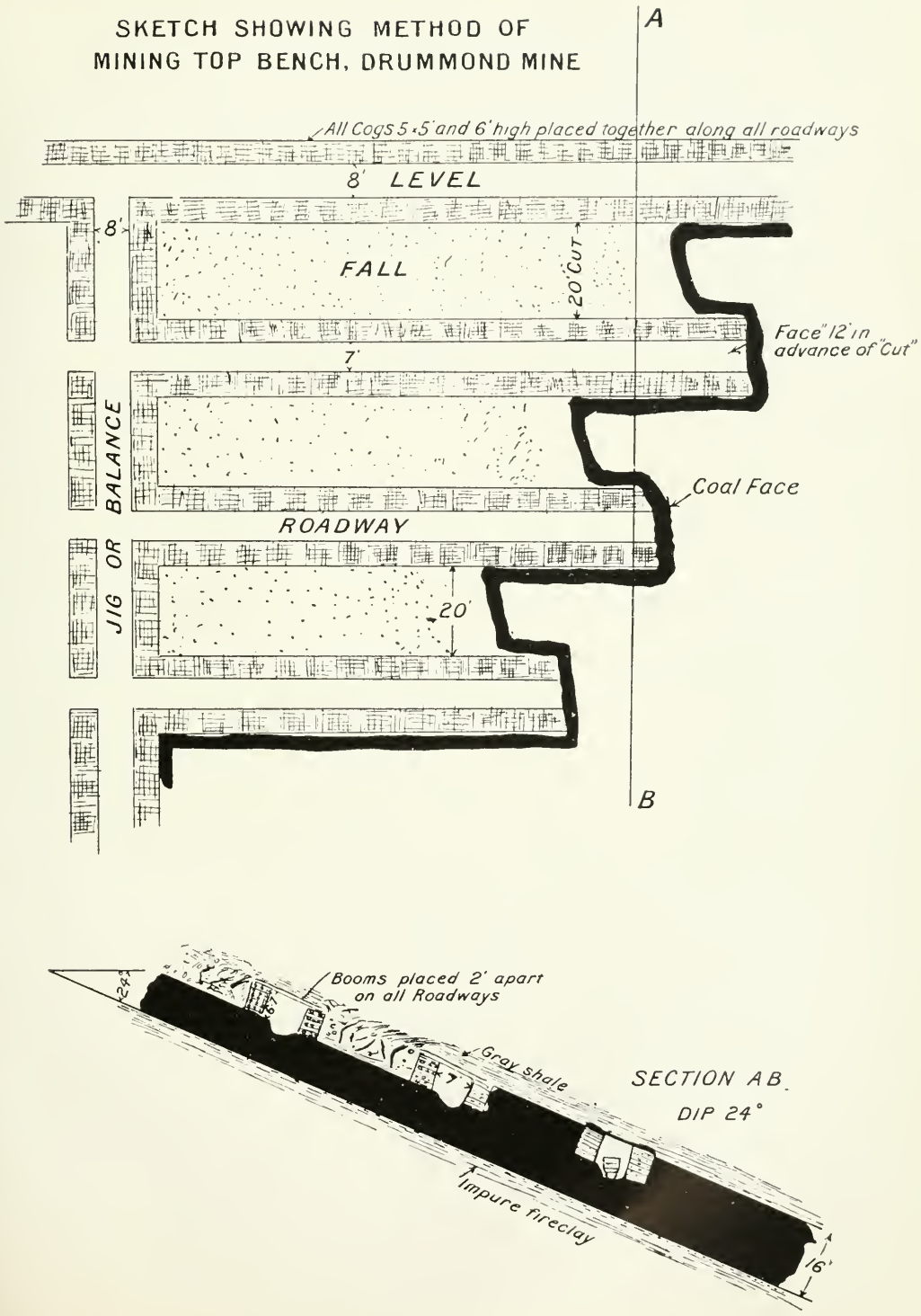
The coal is lowered to the level by means of balances and chutes. The pillars are drawn by working out the upper pillar a little in advance of the lower, and, when a fall takes place in the bottom pillar, a large quantity of the coal in the pillar is easily secured. The old method used was to drive single bords close to the roof and split the pillar with a 20-foot or 30-foot room driven the full thickness of the seam.

Owing to the great thickness of the coal, the high pitch of the seam, and the fact that some of the coal is badly crushed, it is not possible to get a high extraction by means of the methods now in use.

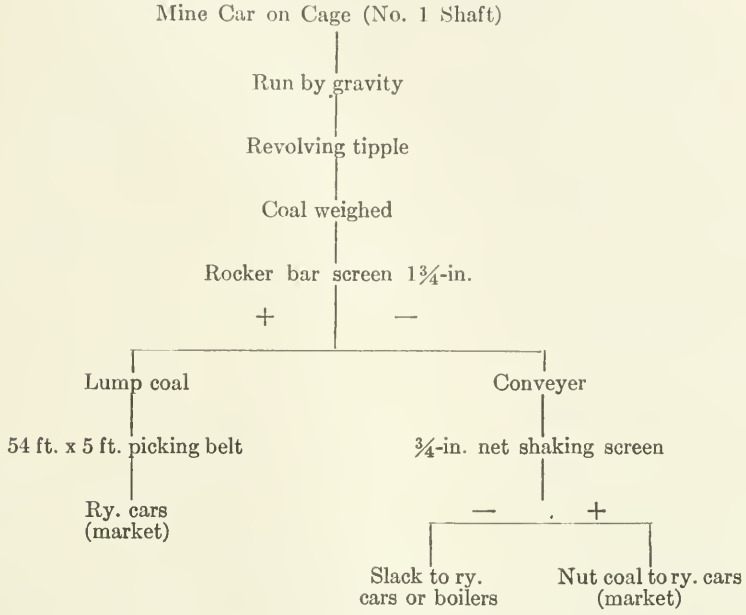
Ventilation and Lighting.—The mine is ventilated by a 26 ft. by 8 ft. Guibal fan with a capacity of 48,000 cu. ft. of air per minute, direct driven from a 13 in. by 24 in. steam engine. The mine makes gas, and Wolf safety lamps are used exclusively underground.

Blasting Methods.—Blasting is done by means of battery and Monobel powder. Coal-cutting machines are now being installed. The workings are fairly moist but no systematic hygrometer records are kept.

Mechanical Equipment.—Turbine electric pumps are used for pumping the mine water. No. 1 and No. 2 shafts were previously used for hoisting coal, the coal from No. 2 shaft being conveyed to the screening plant at No. 1 bankhead by means of a car haul and hydraulic elevator. They are now connected underground, and the hoisting is done at No. 1 shaft by means of a double drum steam hoist, size of cylinders, 29½ in. by 5 ft. stroke. Each drum is partly cylindrical and partly conical in shape. The conical part tapers from 13 ft. 2 in. to 9 ft. The hoisting rope is 2 in. in diameter. Hoisting is done from four levels—1440 ft., 1200 ft., 962 ft., and 476 ft. The engine is fitted with over-wind and over-speed devices. Four deck cages, having a capacity of four tons of coal each, are used in the shaft.


SKETCH SHOWING METHOD OF
MINING TOP BENCH, DRUMMOND MINE
A
All Cogs 5'·5' and 6' high placed together along all roadways
8' LEVEL
8'
FALL
20' CUT
Face 12' in advance of "Cut"
7'
BALANCE
Coal Face
ROADWAY
JIG OR
20'
B
24°
Booms placed 2' apart on all Roadways
Gray shale
SECTION AB.
DIP 24°
Impure fireclay
16'

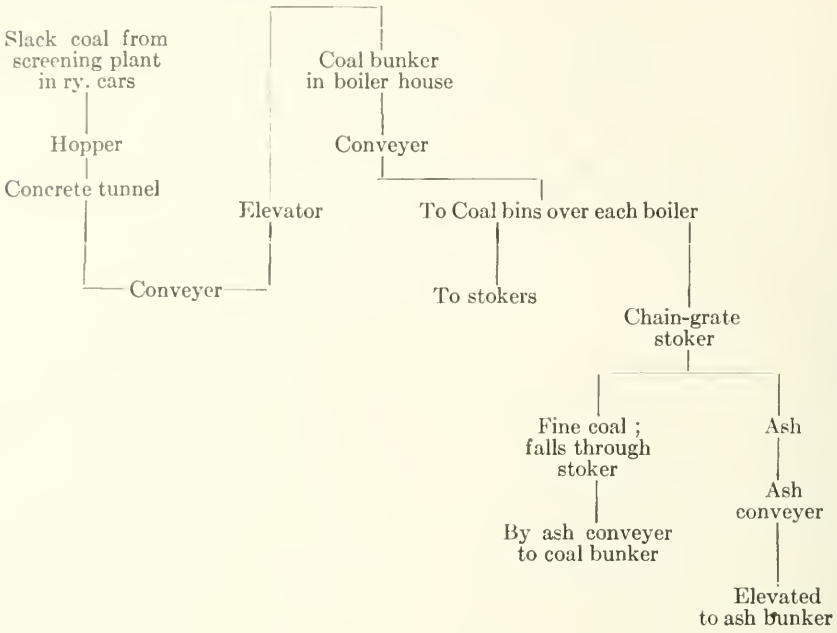
Screening.—The screening plant consists of four units, and has a capacity of 3000 tons per day. The following diagram shows the schedule of screening operations :



Central Power Plant

The central power plant is situated at the Allan shafts, and furnishes steam and electric power for these shafts, as well as for the complete operation of the Albion and McGregor mines.

Boiler Plant.—The boiler plant is contained in a substantial brick building, 78 ft. by 126 ft. long, separated from the power plant by a brick partition. The installation consists of six 450-h.p. water-tube boilers, fired by automatic chain grate stokers. Space is also left for an additional unit of six boilers. The boilers are fired with slack coal, or culm, and, by proper adjustment of the mechanical stokers, almost perfect combustion is obtained. The steam pressure is 150 lbs. per square inch. They are fitted with superheaters for superheating the steam to 572° F. before it is used in the turbines. The diagram shows the coal and ash handling operations :



The accompanying illustration,* from a photograph taken while the plant was in operation, shows that smoke was not coming from the stack.

Power Plant.—The power plant is contained in a brick building 75 ft. by 59 ft., and consists of two 1500-k.w., three 150-volt generators driven by steam turbines of the Curtiss type, the r.p.m. being 3000. Space is also provided for the installation of two similar machines. The illustration facing p. 84 shows one of the units. Electric energy for use in small motors at the Allan shaft is transformed to 525 volts. Electric energy at 3,150 volts is transmitted to the Albion and McGregor mines, a distance of a mile and a half.

Drummond Colliery

This mine is situated at Westville, Pictou County, Nova Scotia, and is owned and operated by the Intercolonial Coal Company, Limited, A branch railway connects the mine with the Intercolonial railway at Stellarton. Water shipments are made from the docks at Abercrombie. ten miles distant, and connected with the mine by the company's railway.

*Facing page 82.

The following coal seams have been found on this property :

Main or Acadia seam	17 feet
Intervening strata	219 feet
Scott Pit seam	12 feet
Intervening strata	54 feet
Third seam	8 feet
Intervening strata	90 feet
Fourth seam	8 feet

Of these, the upper, or Main seam, is practically the only one worked at present, although some work has been done on the Scott Pit seam. The clay seam, under the Third seam, is worked at intervals in order to supply clay for the brick works. Access to this is obtained by means of a rock drift driven from No. 2 slope, Main seam, to the Third seam. The Main seam varies in thickness from 18 ft. near the surface, to about 16 ft. at the bottom of the slope. The angle of dip is about 20°. The mine has been developed by means of three slopes, No. 1, No. 2, and No. 4. No. 1 slope, 8600 ft. in length, is used for hauling coal from the lower levels. A pillar, 30 ft. wide at the surface, increasing to 100 feet at the bottom, separates No. 1 from No. 2 slope. No. 2 slope is used as the riding slope, and for hauling coal (bottom coal) from No. 6 and No. 8 levels, also for hauling the clay from the Third seam. No. 4 slope, about 2000 f'. in length, is used for hauling coal from No. 4 section of the mine.

Nineteen levels have been driven on each side of the main slope (No. 1 and No. 2) every 400 to 600 ft. The upper eight levels have previously been worked ; some of this work having been commenced as early as 1868. The old practice was to work the seam by bord-and-pillar ; 12 ft. of top coal being taken out near the surface, and 11 ft. in the lower levels. This 11 ft. consisted of 9 ft. in the rooms and about 2 ft. of brushing. After the bords had been driven the pillars were removed.

System of Mining.—The present management is now recovering the 6 to 8 ft. of bottom coal left in the old workings. The method employed is as follows : Bords 10 ft. wide are driven in the bottom coal with the old fall for a roof. The bords are kept timbered right up to the face. A false boom 12 ft. long is set in next to the face, and supported on posts 12 in. long, set in hitches cut in on each rib. This boom is put in to hold the roof until the shooting is done, after which permanent booms are put in, supported by three posts on the high side

of the rail. The bord is advanced by shooting two centre cut holes and a bottom rib hole on each side. By this method it has been found possible, not only to recover the bottom coal from areas where pillars had been removed in the top coal many years ago, but also to recover the bottom coal from areas where the top coal pillars have recently been removed.

In the Westville section of the Pictou coal-field, the seams have a high angle of dip, and, as these mines have been in operation for a considerable period, the main slopes are of great length and consequently the cover over the workings is also very great.

The difficulties met with at the Drummond Colliery are as follows :

1. As the cover over the coal, in the lowest levels, amounts to about 2700 ft., the roof and side pressure is very great. This necessitates the frequent brushing of all narrow work.

2. On account of the great thickness of the seam, it is not, under existing conditions, possible to mine the full height of the coal at a single lift.

3. The roof and pavement consist of a soft shale.

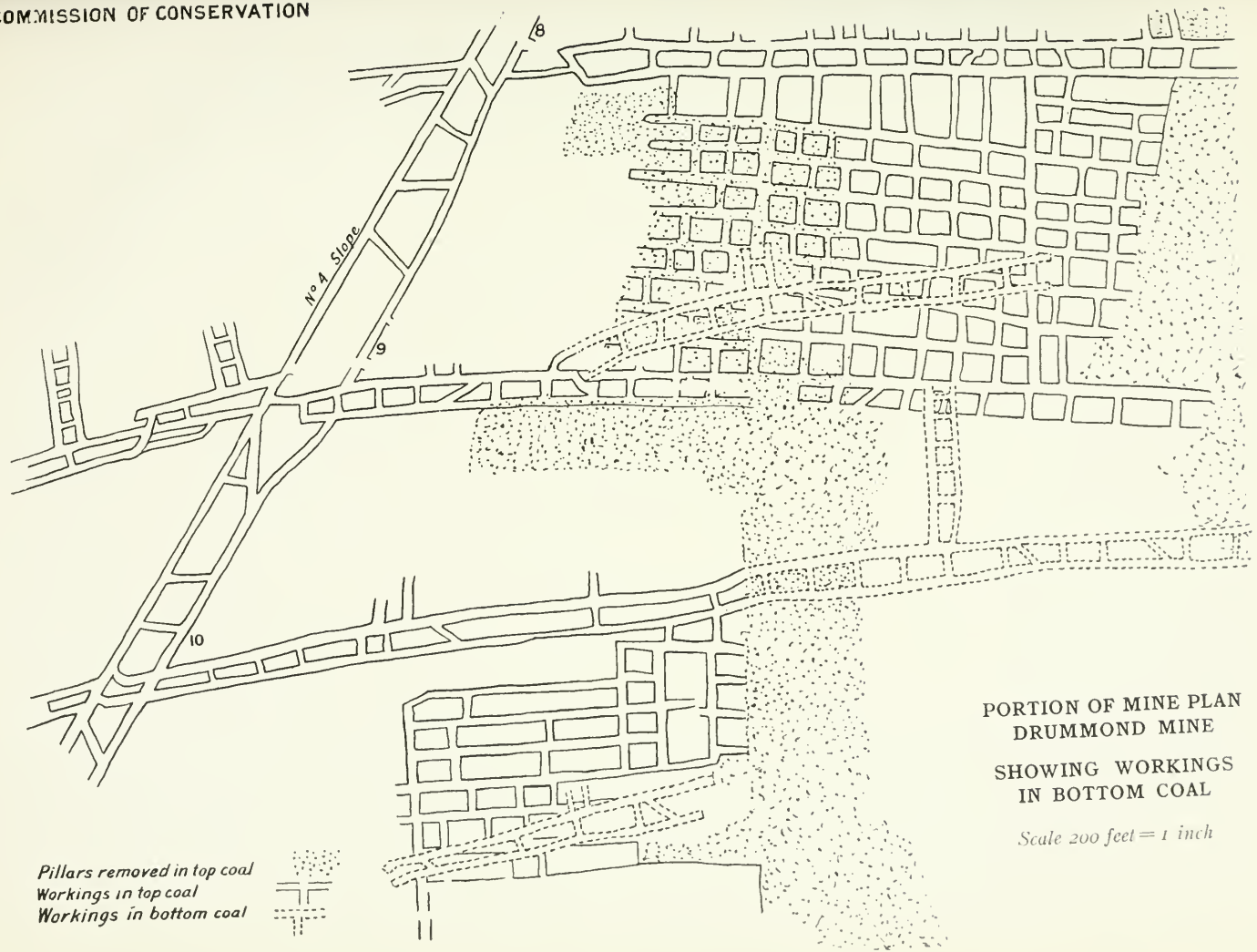
4. The increase of temperature due to increase in depth.

It is a well known fact, that, in order to remedy the effects of great roof pressure, it is necessary to adopt a system of mining by which the faces can be developed as rapidly as possible, so that the coal may be exposed to the weight for a very short time, and the places closed as soon as possible. The following is a description of the method devised by the management, and in use at this mine :

The system of mining used is what might be called advancing bord-and-pillar, in which the pillars are drawn a short distance behind the bord, while the bord is still advancing. The mine is laid out as in ordinary bord-and-pillar work. Levels are driven off the main slope 400 to 600 ft. apart, and jigs are opened off the levels every 300 feet, and driven to the rise as far as the next level. The roadway in all levels is 8 ft. wide, and is supported on each side by a row of 5 ft. by 5 ft. wooden cogs. The jig roadway is also supported by wooden cogs, and is 6 ft. wide between cog walls. Where the roadways are used for ventilation, all cogs are filled solid. Roadways, 7 ft. wide between cog walls are driven from the jig every 37 ft. centre to centre. (See diagram facing page 88).

Cog Walls.—The cog walls along each side of the roadways are 6 ft. high, but two or three feet of brushing is taken out between the walls, so that the roadways are about 9 ft. in height. The roof is supported by booms 18 in. to 24 in. apart, placed across from one wall to the other. As soon as the roadway has been driven a short distance, the 20-foot pillar is drawn to within 10 ft. or 12 ft. of the face of the

COMMISSION OF CONSERVATION



PORTION OF MINE PLAN
DRUMMOND MINE

SHOWING WORKINGS
IN BOTTOM COAL

Scale 200 feet = 1 inch

Pillars removed in top coal
Workings in top coal
Workings in bottom coal

roadway. The coal from this cut is loaded into cars, on the roadway, by means of a small iron chute, placed in a space left between two cogs, on the upper side of the roadway. These spaces are about 12 ft. apart and are locally known as "cundies." There are generally four places in a jig working at the same time, and the upper workings are kept a short distance ahead of the next lower workings, as shown in the diagram. The workings from one jig are driven to meet those from the next jig. By this method only the top coal is, at present, recovered, but, from experience gained in other portions of the mine, it is evident that eventually the bottom coal may also be recovered.

In 1911 about 12 lineal feet of timber were used per ton of coal mined.

Blasting Methods.—No blasting is done except in mining the bottom coal and then Monobel and battery are used. The mine is fairly damp on the haulage roads, but somewhat dusty at the working places. No systematic hygrometric records are kept and sprinkling is not resorted to.

The mine has a capacity of 1000 tons per day, but the actual average is about 800 tons. There are about 600 men employed underground and 230 above ground.

Ventilation and Lighting.—The mine is ventilated by means of a Walker fan, 20 ft. in diameter, which is rope driven from a compound steam engine. The quantity of air in circulation is 50,000 cu. ft. per minute. The water gauge is 6.5 in. Wolf safety lamps are used exclusively underground.

Mine Equipment.—The boiler plant consists of :

Five 212-h.p. water-tube boilers and one, 200-h.p. boiler, situated at the main slope ;

Five boilers, with an aggregate of 900 h.p. are situated at the compressor plant ;

Three 60-h.p. boilers are situated at the Scott pit.

Hoisting Machinery.—The hoisting machinery consists of : One engine 24 in. by 42-in. stroke, drum 8 ft., which is situated at No. 2 slope.

One engine 28 in. by 60-in. stroke, drum 8 ft., which is situated at No. 1 slope.

One engine, 16 in. and 24 in. by 26-in. stroke, geared 4 to 1, drum 8 ft., situated at No. 4 slope.

There are also a number of small compressed-air hoists, situated underground, which are used for mine haulage and sinking purposes. A number of compressed-air pumps, which pump the mine water in five lifts to No. 5 level, are installed underground. From No. 5

level the water is pumped to the surface, by means of a steam pump. A Walker air compressor, capacity 3100 cu. ft. of air per minute, is used to furnish power for mine haulage and pumping purposes.

At the bankhead the coal is sized over 2-in. and ¾-in. screens. The screens at No. 2 and No. 3 are each driven by an engine 8 in. by 12-in. stroke. The culm from the screens is conveyed to the boilers and to the washery. The washed culm is coked in thirty-six beehive ovens.

COAL MINES OF SASKATCHEWAN

IN *Coal Fields of Manitoba, Saskatchewan and Eastern British Columbia*, Mr. D. B. Dowling summarizes the geology of the coal-bearing rocks as follows :

In Manitoba, Saskatchewan, Alberta and eastern British Columbia, the coal is found in three distinct horizons in the Cretaceous, separated by shales of marine origin. The lowest is practically the base of the formation, and is considered Cretaceous from its fossil flora; though it lies just above the Fernie shale, now understood to be of Jurassic age. The line of demarcation is not very sharp, as the shales in their upper part become interstratified with sands, and gradually pass into a sandstone formation containing coal seams—called by Dawson the Kootanie. The age of the Kootanie, if not Jurassic, must be early Cretaceous. Above this, the Dakota does not appear to be coal-bearing in an economic sense, and not until near the top of the Belly River or Judith River formation is reached does there appear to have been land conditions of sufficiently long duration for the growth of material to form coal beds. The coal horizon in the Belly River contains but few workable seams ; but its areal distribution makes it important. The third coal horizon is at the top of the Cretaceous, and includes part of the old Laramie formation. The upper part in Alberta is a fresh-water deposit, and is classed coal-bearing. What is believed to be the same horizon as the Lower Laramie, bears many lignite seams, and in Alberta is given the name Edmonton formation, the highest member of the Cretaceous.

The three coal horizons are as below :

(1) Edmonton formation in Alberta, and Laramie in Saskatchewan.

(2) Belly River (Judith River) formation.

(3) Kootenay formation.

The principal localities where coal mines are operated in these formations are as follows :

Laramie formation—Souris district, Saskatchewan.

Edmonton formation—In the vicinity of Edmonton, Alberta.

Belly River formation—In the vicinity of Lundbreck, Lethbridge and Taber, Alberta.

Kootenay formation—Banff and Crowsnest Pass districts.

The coal-fields of Saskatchewan are situated in the southern portion of the Province and extend from the boundary of Alberta on the west to the Manitoba boundary on the east. The area underlaid by coal is estimated at 5,500 square miles, containing in all about 18,000,000,000 tons of lignite coal. At the present time, mining operations are confined to the southern portion of the field.

The report of the Department of Public Works of the Province of Saskatchewan, 1911, states that twenty-nine mines were in operation in this field in 1911 and that 175,134 tons of lignite were produced. In 1911, the writer visited this district and gathered material for the following brief description of the principal mines in operation at that time.

Bienfait Mine

This mine is owned by the Canadian Pacific railway, but is now being operated under lease. It is situated about three quarters of a mile from Bienfait, a station on the Souris branch, to which it is connected by means of a railway spur. The coal seam averages about 21 ft. in thickness and lies practically flat.

Method of Mining.—The room-and-pillar system of mining is used. (See diagrammatic sketch facing p. 96.)

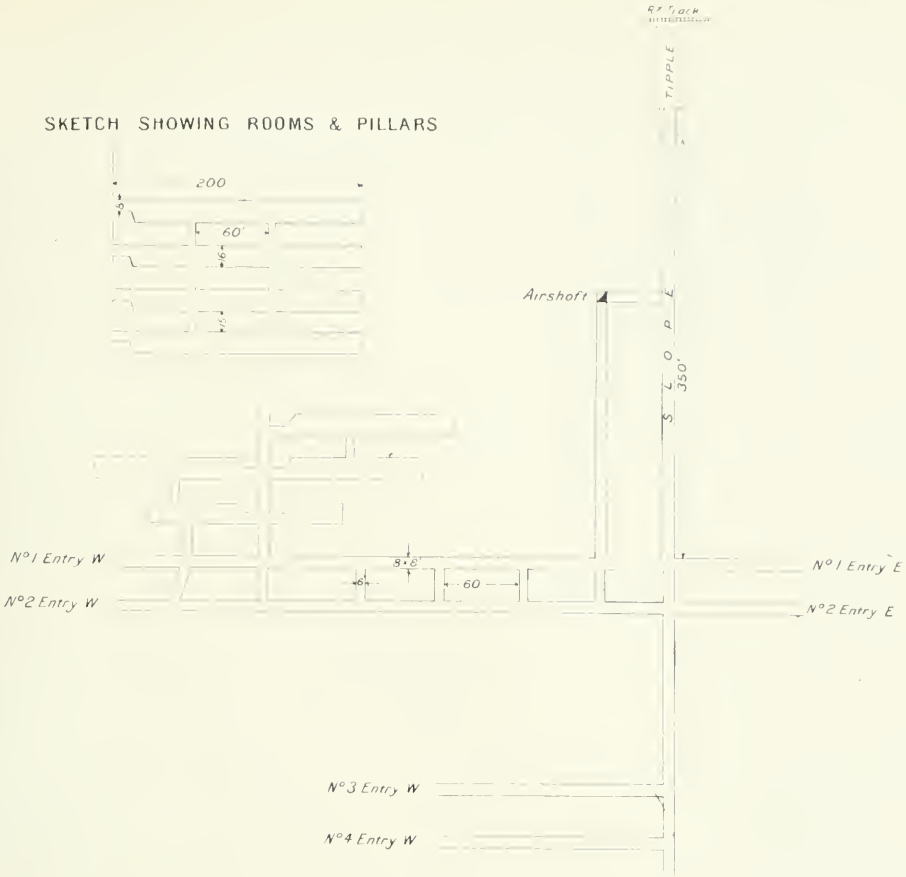
The entrance to the mine is by slopes which have been driven from the surface through the gravel and clay for a distance of about 350 ft. The coal is encountered at a depth of 60 ft. from the surface. The main entry is driven east and west from the foot of the slope. Pillars 20 ft. in thickness are left between the main and the counter entries. Side entries, 8 ft. by 8 ft., are run from the main ones and, from these, the rooms are opened off every 33 feet from centre to centre. The rooms are opened from the entry with a width of 8 ft. for a distance of 10 ft. and then widened out to a width of 16 ft. They vary in length up to 200 ft.

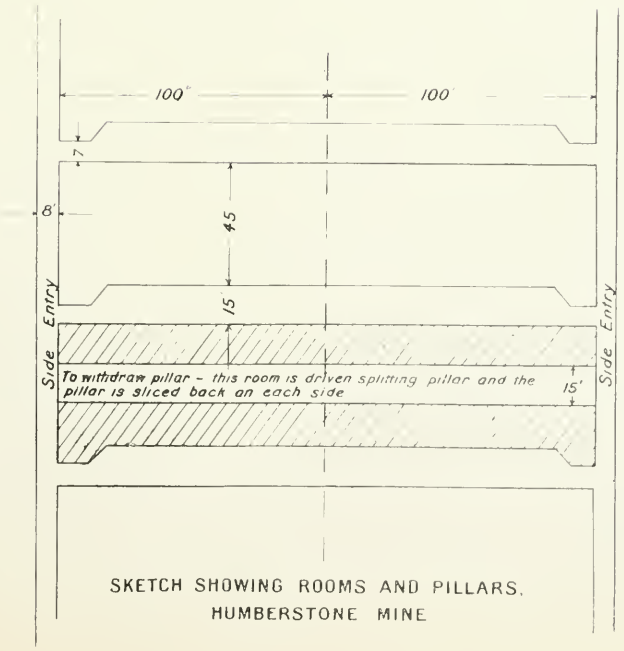
Ventilation.—Cross-cuts for ventilation are driven through the room pillars every 60 feet. The ventilation is induced by steam pipes in the slope. No methane is found in this mine. The mine is generally damp.

Blasting Methods.—Shooting off the solid is practised, and black powder is used. The shooting is done at 12 (noon) and 6 p.m.

Timbering.—As the mines are situated at a long distance from where mine timbers can be obtained, the freight rates on the latter are high. Owing to this and to the fact that the coal is of a very low grade, the operators, as a matter of business, use as little timber as they can, and, consequently, a low extraction of coal is obtained.

SKETCH SHOWING ARRANGEMENT OF MINE ENTRIES
BIENFAIT MINE





SKETCH SHOWING ROOMS AND PILLARS.
HUMBERSTONE MINE

Extraction.—During the month of May, 1911, about 1500 tons of lignite were mined. The coal is used for domestic and steam purposes. Although the thickness of the coal is about 20 ft., only 10 ft. is mined. About 4 ft. of top coal is left to support the roof and 6 ft. of coal is left in the bottom. The immediate roof over the coal is a hard boulder clay ; above this, sand and gravel extend to the surface. Owing to the bad character of this roof and to the fact that there is no solid stratum over the coal, it is necessary to leave in the top coal. Where larger pillars are left and where the bottom coal is attacked soon after the opening of a room, the bottom coal may be recovered, though, as yet, practically none has been recovered. The present extraction from the mine is about 30 per cent of the total coal and no pillars have yet been robbed. Where the roof is as bad as in this case, it is better to take out the pillars as soon as possible after the rooms have been driven.

Manitoba and Saskatchewan Coal Company

This mine is situated four miles distant from Bienfait, and is connected with the Souris branch of the Canadian Pacific railway, by a mine spur.

Method of Mining.—The coal bed, about 12 ft. in thickness, lies flat and is covered with about 80 ft. of sand, clay and gravel. A double-compartment vertical shaft has been sunk through the clay and gravel and the coal is hoisted to the surface by means of a self-dumping cage. The method of mining used is pillar-and-stall. The mine is laid out with the main entries running north-and-south and the side entries east-and-west. The width of these entries is 9 ft. and the height 9 ft. The rooms are driven 15 ft. wide and 9 ft. high ; the pillars are 54 ft. square. (See sketch facing page 98). The rooms are driven in panels consisting of 36 pillars, and as soon as the work has progressed far enough in a panel, as many of the pillars as possible are removed. It has been found that a greater percentage of the pillars can be recovered in this way if the pillars are attacked as soon as possible after the rooms have been finished. If the pillars are allowed to remain for any length of time, the roof settles and heavy pressure is brought to bear upon them. Upon attempting to withdraw them the roof-coal and hard clay and gravel over the coal breaks, and caving results. In this way, not only is a low extraction obtained from these pillars, but the adjoining ground is disturbed, thus preventing a high extraction from subsequent pillars.

The sketch (facing page 98) shows the method of mining and the order in which the pillars are removed. Where the ground is bad, the pillars are split by three 18-ft. rooms, leaving 6-ft. pillars to

hold the roof and protect the next room pillar. In the case of (B) where the roof is very bad, a diagonal room is driven through the pillar and as much of the pillar as possible is recovered by slicing back.

Ventilation.—The mine is ventilated by a direct-driven Sterling exhaust fan.

Blasting Methods.—In this mine, the blasting is done by the miners, black powder and squib being used. One pound of powder is used for every 2 tons of coal mined. The powder is charged into the holes in paper cartridges and clay, dug in the mine, is used for tamping the hole.

No gas has been found in the mine and open lamps, burning seal oil, are used by the miners.

Timbering.—The main entries are timbered with round sets, and in the rooms where the roof is bad, sets are also employed. Usually one prop 9 ft. long is used for every ton of coal mined.

Output.—This mine has a capacity of 1,000 tons per day of 10 hours, but, during the summer months, the demand for coal is small so that the maximum output is approached only during the autumn and winter. In 1910, the output was 60,000 tons, and, during the five months of 1911, the output amounted to 40,000 tons.

Preparation of Coal for Market.—Although two sizes—screen and pea coal—are made, about 60 per cent of the coal sold is shipped as run-of-mine. The coal is used for domestic and power purposes. Over 10 per cent of the coal that goes to the screens is too fine to be marketable. It is taken a short distance from the mine, dumped on the prairie and burned. During the four years that this mine has been in operation, over 12,000 tons of screenings have been destroyed in this way. It is impossible to store this slack coal at the mine as it takes fire easily from spontaneous combustion.

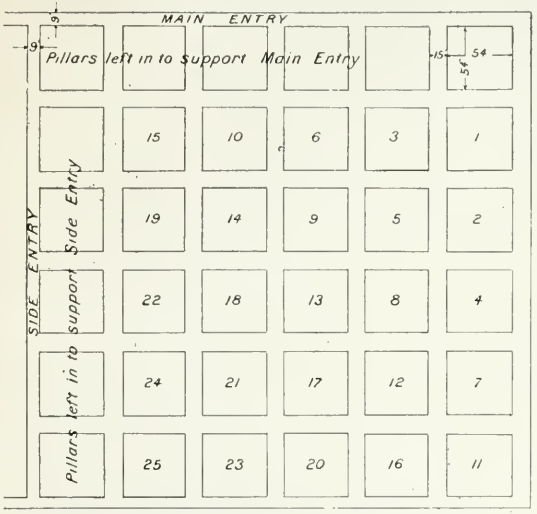
Extraction and Waste.—The coal seam averages 12 ft. in thickness, but about 9 ft. only is mined, 3 ft. of top coal being left in to support the roof. The proportion of coal taken out in advance work is about 25 per cent, and about 60 per cent of the pillars are recovered, giving a recovery of about 70 per cent—excluding roof coal—or a recovery of 52.5 per cent, including the roof coal. Of this, 10 per cent is burned as slack, leaving a total recovery of marketable coal of a little over 47 per cent.

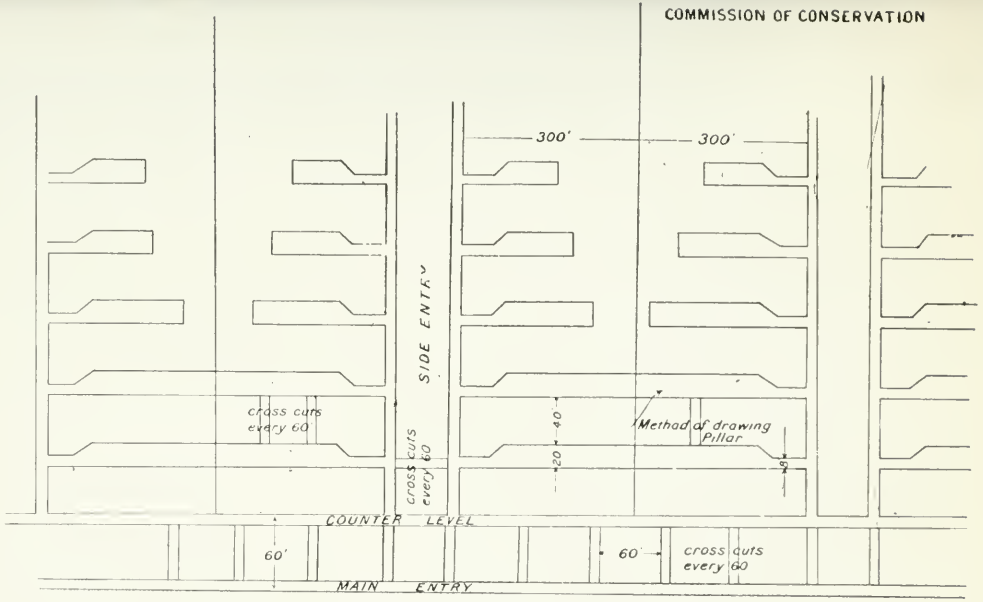
Western Dominion Colliery Company

This mine is situated on a mine spur of the Souris branch of the Canadian Pacific ry., about five miles distant from Bienfait. It has a capacity of 1000 tons per day and is one of the largest mines in the district.

SKETCH SHOWING PANEL SYSTEM
MANITOBA - SASKATCHEWAN COAL ...

Note.- Numbers denote the order in which the Pillars are removed.

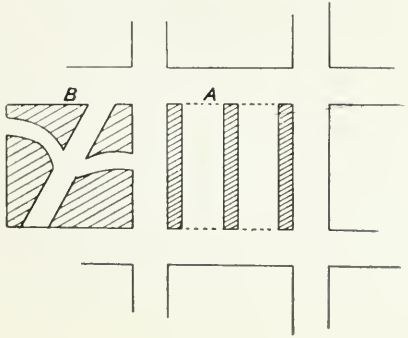




SKETCH SHOWING METHOD OF MINING
DIAMOND CITY COAL COMPANY

SKETCH SHOWING THE
METHOD OF WITHDRAWING PILLARS WHERE ROOF IS BAD

A - Bad Roof B - Very Bad Roof



Method of Mining.—The coal seam averages 7½ ft. in thickness and is covered with 90 ft. of sand, clay and gravel. The system of mining used is pillar-and-room. The entrance to the mine is by a slope. Main entries, 7 ft. 6 in. by 7 ft. 6 in., are driven at right angles to the slope and the rooms are opened off the entry every 29 feet, centre to centre. The length of the rooms is 200 feet, but every 400 feet parallel main entries are driven and the rooms are opened off from them and driven to meet each other. The rooms are driven ten in a battery, and as soon as a room is driven 200 feet the pillar is sliced longitudinally on the return. The slice varies from 3 to 6 feet in thickness, depending on the character of the roof. The side entries are driven 6 ft. 6 in. wide. The entry pillars, 20 feet wide, are also extracted.

The haulage system on the main levels is by electric locomotives operated by direct current at 150 volts. The ventilation is induced by chimney and furnace. No gas has been detected in the mine and open lights are used.

Blasting Methods.—Chain coal-cutters are used for undermining the coal in the rooms, and black powder ignited by squib is used for blasting. The shooting is done by the miners at any time. Clay, dug in the mine, is used for tamping.

Timbering.—The entries are well timbered with sets every 5 feet. The rooms are usually timbered with props only. One prop is used for every 3 tons of coal mined.

Output.—The following table gives the output of the mine from 1904 to 1910.

Year	Output in Tons
1904	94,850
1905	98,626
1906	81,173
1907	84,119
1908	71,691
1909	91,811
1910	90,695

Preparation for Market.—Sixty per cent of the output is shipped as run-of-mine, but about 9 per cent of the production is wasted and burned on the prairie as slack coal too fine to be marketable.

Estevan Coal and Brick Company

The mine and brick plant of this company are situated on a spur line of the Canadian Pacific ry., about one mile south of Estevan. The coal mined, about 40 tons per day, is used for brick burning. The plant produced about 12,000,000 brick in 1911.

The coal, 8 ft. in thickness, is overlain by about 12 ft. of clay, which is used for making soft brick. Under the coal, there is a 30-ft. seam of clay, which is used to make a red brick. The upper clay is obtained by stripping off the surface cover and the coal thus exposed is then mined. The lower clay is mined by open cut work. As the coal obtained from stripping is not sufficient to meet the requirements of the brick plant, underground mining is also resorted to.

Method of Mining.—As the coal dips slightly into the hill, a slope has been driven on the coal and the entries are driven from the slope at an angle of about 45°. The rooms are opened off the entries and driven parallel to the direction of the main slope.

The rooms are generally 200 ft. in length and 16 ft. wide. The height of the room is 6 ft. and 2 ft. of top coal is left for a roof. Fifteen-foot pillars are left between the rooms. When robbed, about half the pillars are recovered

Blasting.—Hand mining and shooting off the solid is practised. Black powder is used for blasting.

The haulage on the main slope is by a hoisting engine, while horses are employed in the main entries underground.

Extraction.—About 55 per cent of the coal is recovered in advance work, and, as about half the pillars are recovered, the extraction—excluding the top coal—is about 75 per cent. The recovery based on total coal is 56 per cent.

COAL MINES OF ALBERTA

THE coals of the Belly River formation and the Edmonton formation grade between lignite and bituminous. The coals that belong to the Belly River horizon are found over an area of about 25,000 square miles ; of this area 5,000 square miles are estimated to contain 13,000,000,000 tons of coal. The amounts contained in the two provinces of Alberta and Saskatchewan have been estimated at 10,000,000,000 tons and 3,000,000,000 tons, respectively. The principal coal mines within this area in Alberta are near Lethbridge, Taber and Lundbreck.

The coals of the Edmonton formation are generally lignites ; but, in the foothills, they grade up to bituminous. The total area of workable coal has been estimated at 12,800 square miles with a probable coal content of 71,000,000,000 tons. The principal coal mines within this area are near the city of Edmonton.

Belly River Formation

The following are brief notes on the principal mines operating in the Belly River formation :

Diamond Coal Company

The mine is situated on the east bank of the Belly river, about fourteen miles north-east of Lethbridge. A seven-mile spur from the Crowsnest branch of the Canadian Pacific ry. connects the mine with the railway at Kipp.

The coal seam is comparatively flat and outcrops on the river bank ; the strike is about N. 30° W. The thickness of the seam varies from 48 in. to 52 in. and is frequently broken by faults.

The following represents a section of the seam taken in one of the rooms :

Draw slate	11 in.
Clay	1 "
Coal	18 "
Clay	2 "
Coal	30 "
Bone coal and black-jack	11 "

The pavement is black-jack.

The coal is undercut by compressed air punch machines, the mining being done in the eleven inches of black-jack. The mine is

worked by a level drift driven into the hill from the outcrop on the river bank. The coal is hoisted from the drift to the level of the prairie above by an outside incline 1,000 ft. in length.

Method of Mining.—The system of mining used is pillar and single stall. The main entries are driven parallel to the strike of the coal and are 8 ft. wide. The side entries, 8 ft. wide, are driven at right angles to the main entries every 300 feet. Rooms are opened off the entries every 60 feet, from centre to centre. Sixty-foot pillars are left between the main and counter levels. The accompanying sketch* shows the general method followed.

Pillar Robbing.—After the rooms have been driven, the pillars are removed by taking strips off the pillar, beginning at the face of the room. About 40 per cent of the coal is removed in advance work, and nearly all of the pillars are recovered in retreat.

Blasting Methods.—The coal is first undermined by machines and shooting is done by squib and black powder. The tamping material is clay obtained in the mine. The shooting is done by the miners at noon or at the end of the shift. This mine is not subject to windy shots, nor has it experienced any explosions.

The roof is of draw slate and about 10 in. or 11 in. of it falls immediately in the rooms. No gas has been found in the mine, and open lamps are used exclusively.

Ventilation.—The mine is ventilated by a Sirocco fan used as a force fan, which delivers about 41,000 cu. ft. per minute. The fan is driven by a noiseless chain from a 75-h.p. motor. The water gauge is 1 inch. There are no splits in the ventilation.

In timbering the mine, about 8 lineal feet of props are used per ton of coal mined.

The coal is sized at the tipple by means of bar screens 12 ft. in length, and none is shipped as run-of-mine. The screen sizes used are 1¼in., ¾in., and ¼in., making lump, nut and pea coal. All coal under ¼ in. is wasted.

The following gives the percentages of the different sizes :

Lump coal, about 75—79 per cent.
Nut coal, about 5—6 per cent.
Pea coal, about 6—7 per cent.
Slack (wasted), 9—12 per cent.

The coal is loaded direct into railway cars. The mine has no storage-bin capacity, but has a track capacity for about 13 thirty-ton loaded railway cars and the same number of empty cars.

Power Plant.—The power plant consists of : (*a*) One cross-compound air compressor with a capacity of 3120 cubic feet per minute,

*Facing page 98

which is used to furnish power for mine haulage and pumping. (*b*) One 250 k.w., a.c. three-phase generator, for lighting and power purposes.

A 30-h.p. motor for operating the tipple.
" 10-h.p. " " machine shop.
" 6-h.p. " " boiler conveyer.
" 75-h.p. " " driving a Sirocco fan.
" 35-h.p. " " water-works.

The boiler plant consists of two 250-h.p. and two 125-h.p. boilers fired by mechanical stokers.

Output.—The capacity of the mine is about 600 tons per day, but the average daily output is about 200 tons.

Lethbridge Collieries

This mine is situated on a branch of the Crowsnest branch of the Canadian Pacific ry. about one-half mile distant from Kipp. The coal seam is the same as that worked at Lethbridge, Diamond City and vicinity.

The mine is opened up by means of a three-compartment 17½ ft. x 22 ft. vertical shaft, the coal being intersected at a distance of 573 ft. from the surface. The seam is flat and occasionally broken by normal and up-throw faults.

Method of Mining.—The system of mining is pillar-and-stall. The main and side entries are driven 8 ft. wide. The shaft pillar is 250 ft. x 400 ft., and a 60 foot pillar is left between the main and counter levels. The side entries are driven 1000 ft. apart and the rooms are driven to meet each other from a pair of butt entries. The sizes of the rooms are 250 ft. long and 18 ft. wide. The room pillars are 22 ft. wide. The proportion of coal taken out in advance work is about 50 per cent. As it has, thus far, been found impossible to recover a large percentage of the room pillars, the company is now experimenting with several methods. Longwall method is being tried and also pillar-and-room—the rooms being 18 ft. wide and the pillars 54 ft. wide. These pillars will be drawn by splitting them with an 18 foot room and drawing the remainder in retreat. The mine has a capacity of 1600 tons per day.

Ventilation.—It is ventilated by a rope-driven Walker fan, 12 ft. in diameter, and 4 ft. wide, delivering 150,000 cu. ft. of air per minute. The fan engine is 16 in. by 30 in. in stroke. The average water gauge is 1 in. There are four air splits in the ventilation system.

Blasting Methods.—The blasting is done by battery and shot-firers at any time. The powder used is Monobel with No. 6 detonators. Forty per cent dynamite is used for brushing the roof and floor. The

tamping material used is clay dug in the mine. Wolf safety lamps are used and gasoline is burned as oil.

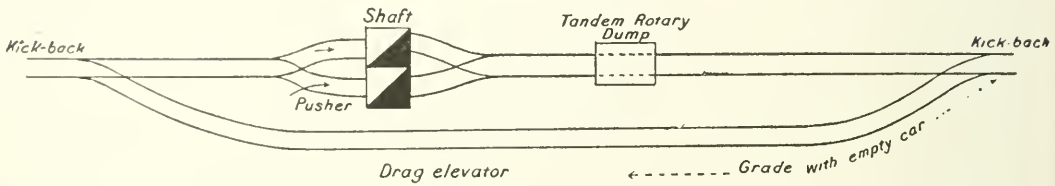
Hoisting.—Hoisting in the main shaft is done by a duplex steam engine 26 in. by 54 in. stroke. The diameter of the drum is 12 ft. 9 in. the ropes 1⅜ in. in diameter. The man-engine is a second motion hoist, size of cylinders 14 in. by 26-in. stroke. The diameter of the drum is 8 ft.

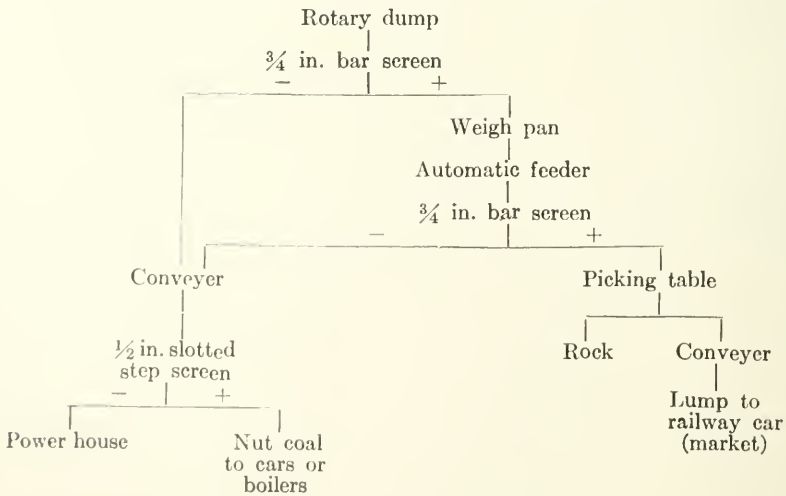
Tipple.—The head-frame and tipple are made of steel and the coal is sized in a similar manner to that described under No. 3 mine, Alberta Railway and Irrigation Company. The tipple machinery is driven by four 10 h.p., one 7 h.p., and one 5 h.p. motors.

The following diagram shows the tipple flow sheet :

SKETCH SHOWING

ARRANGEMENT OF TRACKS ON TIPPLE





A cradle box-car loader is used for loading box cars.

The boiler plant consists of a half unit of 4 x 250-h.p. water-tube boilers with chain grate stokers and induced draught. The boiler plant is also fitted with two 1000-h.p. feed-water heaters.

Power Plant.—The power plant consists of :

A 3000 cu. ft. capacity cross-compound air compressor for furnishing power for the coal cutters and pumps.

A 350-h.p. cross-compound, vertical steam engine direct coupled to a 250-k.w., a.c. generator, for furnishing power and light. The mine is also equipped with carpenter shop, machine shop, etc., for doing ordinary mine repair work.

The mine water is pumped to a central station by means of four 4½ in. x 12 in. pumps ; the water is pumped to the surface from the central station by means of an 8 in. x 12 in. x 18 in. mine pump.

Alberta Railway and Irrigation Company

This company operates the Galt mines at Lethbridge, and at the present time, mining is being carried on in two mines—No. 3 and No. 6.

No. 6 Mine

This mine is situated three miles from Lethbridge. A spur, 3 miles in length, connects the mine with the Canadian Pacific ry. at that point. The coal is lignitic in character, and occurs in a flat or slightly dipping seam, averaging about 4 ft. 4 in. in thickness.

The following is an approximate section taken in one of the rooms :

Draw slate	11 in.
Clay	1 "
Coal	18 "
Clay	2 "
Coal	30 "
Black-jack	pavement

Method of Mining.—The mine is worked from a perpendicular, four-compartment shaft, 20 ft. x 21 ft. and 400 ft. deep. The elevation of the shaft-collar is about 2936 ft. above sea-level. The seam is frequently disturbed by faults, and, at such faults, a little gas is occasionally encountered.

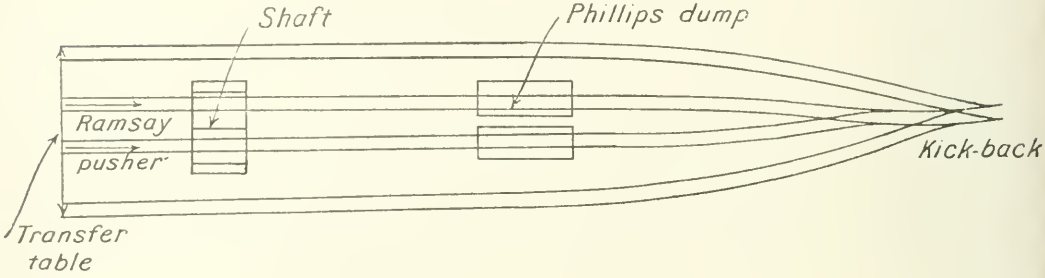
The system of mining is pillar-and-room. (See sketch, p. 108). Every 2000 feet, four parallel main entries are driven for the main haulage and ventilation roads. The butt entries are driven three in parallel every 300 feet. The rooms opened up off the butt entries are 250 ft. in length, and the 50-foot pillars, which are left as barriers to protect the butt entries, are brought back when the room pillars are being removed. The rooms are opened off the butt entries with a width of from 18 ft. to 20 ft. The room pillars are 18 ft. wide.

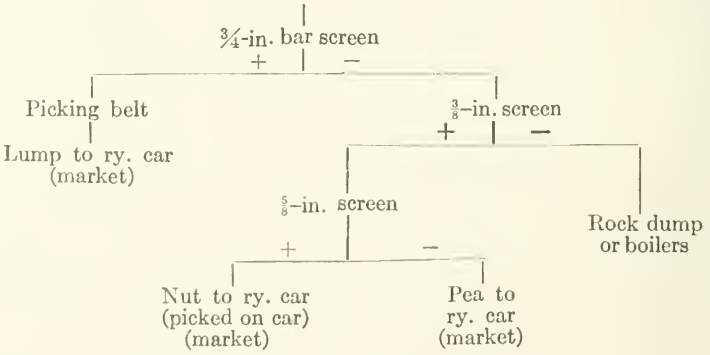
The pillars are first attacked by slicing the pillar back from the last crosscut. The remainder of the pillar is drawn in the same way. In this way 50 per cent of the coal is recovered in advance work and 60 per cent of the pillars is recovered in return, making a total extraction of from 80 to 85 per cent.

Endless rope haulage system is used underground.

The plant has a capacity of 1500 tons per day, but the present actual output averages about 800 tons daily. About 325 men are employed, 290 of this number being employed underground and thirty-five above ground.

The following gives the flow sheet of the steel tipple used for sizing and screening the coal.





The percentage of coal recovered in the different sizing processes is :

Lump	78	per cent
Nut	6	" "
Pea	6	" "
Slack	10	" "

The slack (10 per cent of the output) is wasted, as there is no sale for this product.

The hoisting in the shaft is in counterbalance, and the cages are loaded with two cars each, in tandem. At the pit-head, the loaded cars are removed from the cage by means of a Ramsay pusher, which, at the same time, pushes two empty cars on to the cage.

Ventilation.—The ventilation is produced by a rope-driven Sirocco fan which delivers 60,000 cu. ft. of air per minute. The average water gauge is 2¼ in., and there are twelve air-splits in the ventilation system.

Blasting Methods.—The coal is undercut in the bottom by means of Ingersoll compressed air punchers, twenty being used in the mine. The shooting is done by the miners at any time, black powder and squibs being used. The tamping material used is clay dug in the mine. 'Windy' shots are rare and this mine has never experienced any explosions.

The soft shale roof falls in the rooms and requires timber at the face. About 8 lineal feet of timber are used per ton of coal mined.

Power Plant.—The boiler plant consists of four 250-h.p. water-tube boilers, and there is room for the installation of two more. The boilers are fired by mechanical stokers and air for combustion is supplied by induced draft. A 19 in. x 20 in. Robb-Armstrong engine is used to operate a 200-k.w., a.c. generator. The power generated is used for lighting and power purposes. One cross-compound air and duplex steam air-compressor is used to compress air to 80 lbs. for operating the coal cutters and pumps. The hoisting engine is 30 in. x 48 in. and the drum is 12 ft. in diameter.

No. 3 Mine

This mine is situated on a spur from the Canadian Pacific ry., one mile distant from Lethbridge. The mine is worked from a perpendicular shaft 7½ ft. x 15 ft. and 300 feet deep, from which workings extend from five thousand to eight thousand feet in several directions. The endless rope system of haulage is employed underground, utilizing about 10 miles of rope and operating in six systems. The capacity is about 1000 tons per day, but the actual average is about 700. There are about 350 men employed below ground and 60 above. The system of mining used is pillar-and-room, and is similar to that employed at No. 6 mine. (See sketch, p. 108).

Blasting Methods.—The coal is undercut by Ingersoll punch machines and the shooting is done by black powder and squib.

Mine Equipment.—The tipple is constructed of wood and is well equipped with conveyers, screens, etc., which size the coal into lump, nut, and pea for market. The percentages of the various sized coals obtained are the same as at No. 6. The slack is wasted.

The railway cars are loaded by an Ottumwa box car loader. The boiler plant consists of 12 Robt. Mumford return tubular boilers, aggregating 1500 h.p. The boiler feed water is heated by exhaust steam. A 300-h.p. Vulcan hoist, 20 in. x 36 in. cylinders, with conical drum is used for hoisting out of the shaft.

A Robb-Armstrong engine, driving an Allis-Chalmers-Bullock generator, develops 200 k.w. of electric energy at 2200 volts, which is used to operate a 13½ ft-x 15 ft. Capell fan situated at the air shaft on the river, three-quarters of a mile distant. Two Canadian Rand air-compressors, one supplying 3150 cu. ft., the other 1800 cu. ft. of air per minute, operate twenty-five coal-cutting machines and the mine pumps.

Chinook Coal Company

This mine is situated about five miles from the Lethbridge collieries. The coal seam worked is the same as that described under No. 6 Mine, Alberta Railway and Irrigation Co. The dip is about 3½° to the west.

The entrance to the mine is by a vertical shaft 434 feet deep.

Method of Mining.—The system of mining is pillar-and-room. Cross-entries are driven 800 ft. apart and butt entries 400 ft. apart. The rooms and room pillars are 16 ft. wide. The entries are 9 ft. wide and the entry pillars 50 ft. wide. Advance work only is being carried on and no pillars have yet been drawn. It is the intention of the operators to draw the pillars as soon as all the rooms in a panel have been driven.

Blasting Methods.—The coal is undercut by compressed air coal cutters and the blasting is done by means of black powder and squib. Dynamite is used for blasting in wet places. The tamping material is clay dug in the mine.

Open lights are used underground.

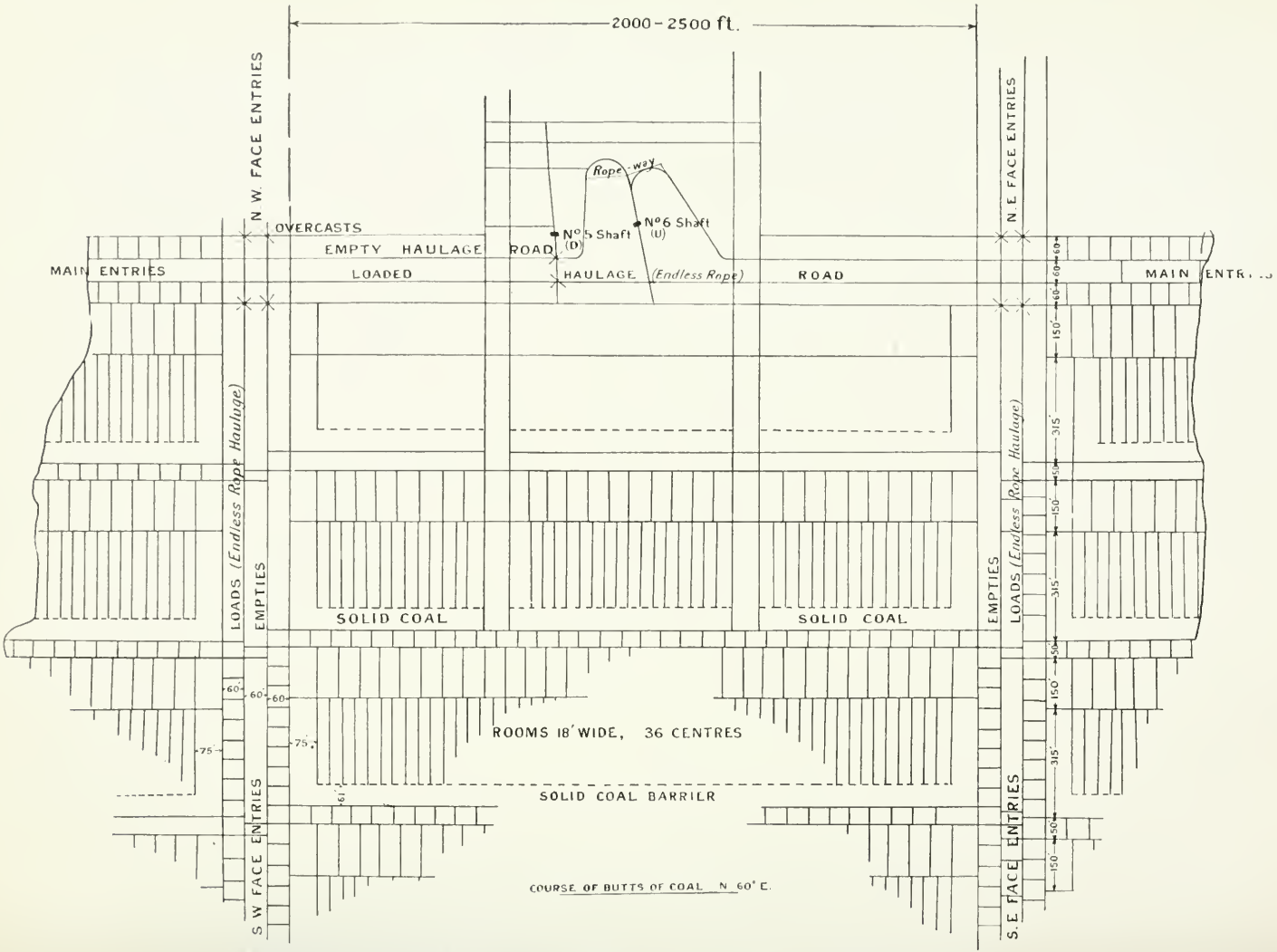
Haulage.—Hoisting in the shaft is done in counter balance by means of a first motion double-drum steam engine, 24 in. by 36-in. stroke. The diameter of the drum is 8 ft. and the hoisting rope is $1\frac{1}{8}$ in. in diameter.

Horse haulage is used underground.

Ventilation.—The mine is ventilated by a Sirocco fan, 8 ft. in diameter, direct-driven from a 15-in. by 24-in. steam engine. It is used as a force fan and delivers 50,000 cu. ft. of air per minute.

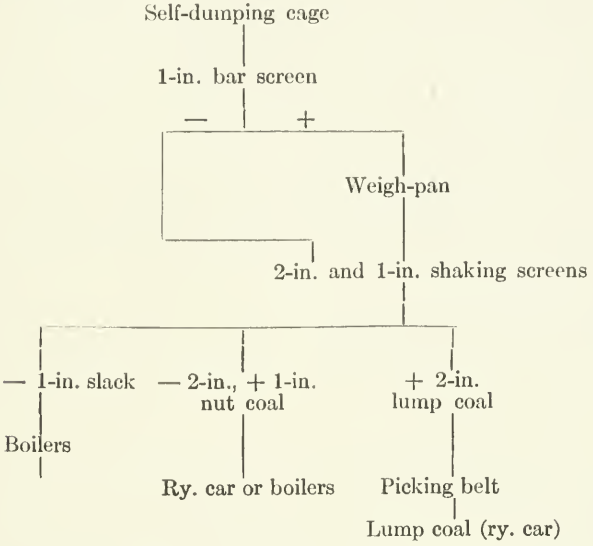
There are three main splits in the ventilating system.

Output.—The mine has a capacity of 650 tons per day, but the actual average output is about 200 tons. There are 100 men employed underground and 20 above ground.



METHOD OF WORKING GALT MINE, No. 6 SHAFT, LETHBRIDGE, ALTA.

The bankhead is of steel construction. The following is an outline of the screening operations :



Mine Equipment.—The boiler plant consists of five 150-h.p. return tubular boilers equipped with mechanical chain-grate stokers and induced draught.

The power plant consists of a 125-k.w. a.c. generator, 2300 volts. The power generated is used for pumping water from the river, two miles distant.

Two air compressors, 1000 cu. ft. capacity each, are used to supply power for coal cutters and mine pumps.

A steam engine, 8 in. by 12 in. is used to operate the screens and the picking belt.

A box-car loader is used for loading railway cars.

The mine is also equipped with machine, carpenter, and blacksmith shops for doing ordinary mine-repair work.

Royal Collieries

This mine is situated at New Lethbridge, on a spur line six miles from the Canadian Pacific ry. The seam, which is the same as that worked nearer Lethbridge, averages about four feet in thickness. It has a slight dip to the north, and is very little broken by faults.

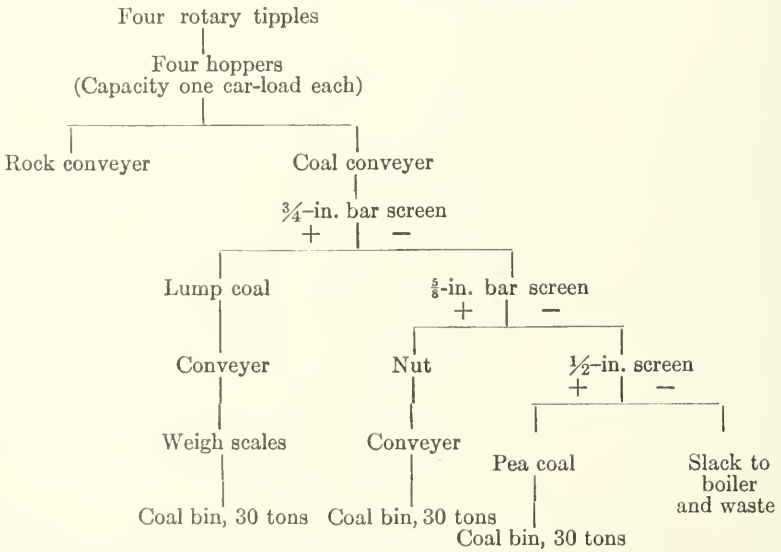
The mine is worked from a 400 ft. slope driven on an angle of about 35°. It has a capacity of 300 tons per day, but the actual average is about 200 tons. There are about 50 men employed underground and 20 above ground.

Method of Mining.—The system of mining used is pillar-and-room. The main and side entries are driven 6 ft. wide. The rooms are 17 ft. wide and 50 ft. long. The room pillars are 18 ft. wide. The proportion of coal taken out in advance work is about 50 per cent and the total recovery is about 80 per cent.

Ventilation.—No gas has been found in the mine and open lights are used exclusively. It is ventilated by a Murphy fan delivering 20,000 cu. ft. of air per minute.

Blasting Methods.—The coal is undercut by Ingersoll compressed-air machines and the shooting is done by the miners. Black powder and squib are used for shooting ; the tamping material used is clay dug in the mine.

Mine Equipment.—The pit-head is of wooden construction. The following diagram gives the flow sheet for preparing the coal for market :



The boiler plant consists of two 80-h.p., and one 125-h.p. return tubular boilers. The company also intends to install two 125-h.p boilers.

The power plant consists of :

A 14 in. x 14 in. steam engine for driving a 20-k.w., d.c. generator. The electricity is used for power and lighting purposes.

One cross-compound air-compressor, 14 in. x 22 in., furnishes air for the coal cutters and pumping. In addition, there is one 350 cu. ft. capacity air compressor. The following machinery is also installed:

A 150-k.w., a.c. generator, and a 17 in. x 16 in. steam engine for driving the same.

Canada West Coal Company

This colliery is situated west of and adjoining the town of Taber on the Canadian Pacific ry., thirty miles east of Lethbridge. The coal seam, 4 ft. 6 in. in thickness, is comparatively flat and lies about one hundred feet beneath the surface. The entrance to the mine is by a slope about 290 ft. in length, driven at an angle of about 19°. The slope is built sufficiently wide to accommodate two tracks.

Method of Mining.—The mine is laid out in panels of 10 acres each, and the method of mining used is pillar-and-room. Entries for roads are driven 9 ft. wide, off which the rooms are turned. The rooms are from 18 to 20 ft. wide and about 150 ft. long. The room pillar widths vary from 12 to 16 ft. The side entries are driven 300 ft. apart, and corresponding rooms from a pair of entries are driven to meet each other.

The proportion of coal taken out in advance work is about 55 per cent. In retreat, about two-thirds of the pillars are recovered; hence the total extraction is about 85 per cent. The coal is loaded into pit cars of about 2000 pounds capacity. These cars are taken from the rooms to convenient sidings along the main haulage-road by horses ; the main haulage is by electric motors. The coal is hoisted up the slope by means of an endless chain ; after being delivered in the tipple house, the cars pass to an automatic dumping device and are weighed and dumped. The empty cars then pass over the weigh basket to a kick-back, run to a down-haul chain and are returned to the mine.

The weigh basket, into which the coal is dumped from the pit cars, is situated immediately over large shaker screens, and the coal is discharged from the weigh basket to the screens. The lump coal passes over a 3-in. screen and is loaded into railway cars by means of an Ottumwa box-car loader. Smaller coal is sized by 1¼-in. and ¾-in. screens, making stove, pea, and slack coal. The pea coal is used for burning under the boilers, while the slack coal, consisting of about 25 per cent of the output, is dumped on the prairie.

The following gives the percentages of the sizes made :

Lump	54	per cent
Stove	15	" "
Pea	7½	" "
Slack	25	" "

The plant has a capacity of 2000 tons per day, but the actual average is about 1000 tons. The number of men employed above ground is about 30 and underground, 300.

The mine is ventilated by means of a Capell fan, 16 ft. in diameter, which delivers 100,000 cu. ft. of air per minute, with a water gauge of 4 in. There are four splits in the ventilation system. No gas has been found in the mine, and electric lights are used on the main roads. Elsewhere, open lights are used exclusively.

Blasting Methods.—The coal is undercut by Morgan-Gardiner electric and Ingersoll compressed-air coal-cutters. The shooting is done by means of black powder and squib. The tamping material used is clay and dirt dug in the mine. The roof above the coal is shale and sandstone and the floor is a hard clay.

Mine Equipment.—The boiler plant is equipped with six 6 ft. x 18 ft. water tube boilers, rated at 165 h.p. each. Firing is done by hand, the coal being brought from the tipple by means of a conveyer, which deposits it in a convenient place just in front of the boilers. Provision is made in the boiler house for the installation of four more boilers. The power plant is equipped with two 150-k.w., 250-volt electric generators, driven by direct connected 200-h.p. steam engines. The generators furnish current for the mine haulage locomotives, electric coal cutters, the motor in the machine shop, for lighting the mine surface plant and company houses, and also furnish current for municipal lighting. There are also two air-compressors of 250-h.p. and 100-h.p. capacity, respectively, which operate the coal cutters and mine pumps.

There are no coal storage bins at the mine, but there is a track capacity for about 28 thirty-ton loaded railway cars and 28 thirty-ton empty cars.

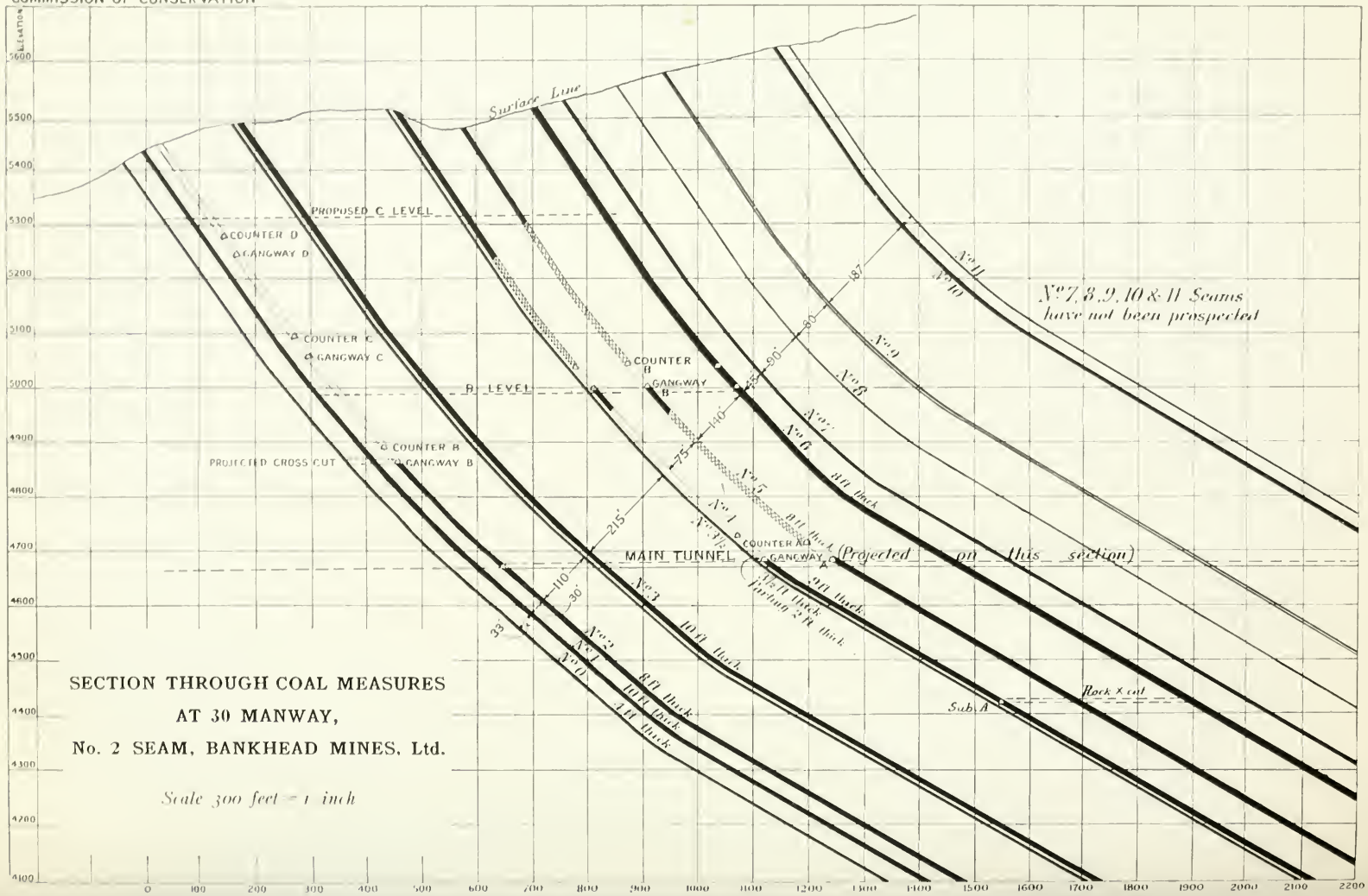
One lineal foot of prop is used per ton of coal mined.

Breckenridge and Lund Coal Company

This mine is situated at Lundbreck, on the Crowsnest branch of the Canadian Pacific ry. Two coal seams are worked in this mine, each of which is about 8 ft. thick and is separated by about 40 ft. of strata. The higher seam dips at an angle of 60° to the east, while the lower is nearly vertical. The seams are folded and rolls are frequent.

Method of Mining.—The entrance to the mine is by slope, 450 ft. long, driven on the No. 1 seam. Hoisting is done from two main levels at 250 ft. and 450 ft. deep, respectively. The system of mining used is pillar-and-stall. No. 1 seam is worked across the pitch and No. 2 is worked on an angle system. Chutes or raises are driven 30 ft. apart and the rooms are driven 8 ft. wide off the raises every 24 ft. The pillars are 24 ft. x 30 ft. and are drawn by splitting the pillar by another raise. The coal in the pillar is then mined and shovelled down the two chutes.

COMMISSION OF CONSERVATION



SECTION THROUGH COAL MEASURES
AT 30 MANWAY,
No. 2 SEAM, BANKHEAD MINES, Ltd.

Scale 300 feet = 1 inch

Blasting Methods.—The blasting is done by shotfirers. Fuse, Monobel powder and No. 6 detonators are used.

The roof is a sandy shale and the floor is a soft clay. Four lineal feet of props are used per ton of coal mined.

Ventilation.—Gas is found in the mine and Wolf safety lamps are used exclusively. The mine is ventilated by a Waddell fan circulating 14,000 cubic feet of air per minute.

The capacity of the mine is 400 tons per day, but the average output is about 275 tons. There are 7 men employed above ground and 42 underground.

Mine Equipment.—The tipple structure is of wood and the coal is sized over a 2-in. bar screen. Two-thirds of the output is shipped as run-of-mine.

The boiler plant consists of one 100-h.p. return tubular boiler. The power plant consists of a 5-k.w. generator. A 12 in. x 14 in. second motion hoist is used for hoisting in the main slope. The underground haulage is done by horses. The mine has a bunker capacity for 100 tons of coal and a track capacity for 9 thirty-ton loaded railway cars and 20 thirty-ton empty cars.

Galbraith Mine

The Galbraith mine is situated near the town of Lundbreck. Two seams of coal, each eight feet in thickness, are worked. They are the same as those worked at the Lundbreck mine. They are not badly faulted, although occasional "pinch outs" occur and dip from 60° to 70° to the west.

Method of Mining.—The entrance to the mine is by means of a slope driven on the outcrop. In the first lift of 200 ft. the mine has been worked out, 50 per cent of the coal being recovered. The system of mining is pillar-and-stall. The levels are driven with 23 ft. centres, and crosscuts are driven every 30 feet. The pillars are drawn by driving a raise up through the centre of a pillar and slicing it on each side of the raise.

As gas is present, Wolf safety lamps are used.

Blasting Methods.—The blasting is done by fuse, No. 6 detonators and Monobel powder. The roof is a soft fire-clay and falls readily in the rooms. The floor is of the same material as the roof.

Ventilation.—The mine is ventilated by means of a Brazil fan with a rated capacity of 40,000 cu. ft. of air per minute.

An incline, 500 ft. in length, connects the tipple with the mine. The tipple is of wooden construction and all the coal is shipped as run-of-mine. There are 33 men employed underground and 10 above

ground. The mine has an output of about 100 tons per day. The bunker capacity is 160 tons and the empty and loaded car capacity is about 300 tons each. Five lineal feet of props are used per ton of coal mined.

Edmonton Formation

The following are brief notes on the principal mines operating in the Edmonton formation.

Clover Bar Coal Company

The Clover Bar mine is situated near the North Saskatchewan river, and is connected with the Grand Trunk Pacific railway by a spur line from Clover Bar station, three miles distant. The coal seam is 7 ft. thick and lies comparatively flat, with slight undulations. A few faults are encountered in the workings.

Method of Mining.—The entrance to the mine is by a two-compartment shaft 85 ft. in depth. The system of mining used is pillar-and-stall. The main and side entries are driven 8 ft. wide. The side entries are driven 400 ft. apart at right angles to the main entry. Rooms are opened off the side entry every 40 feet, centre to centre, and driven to meet the corresponding rooms from the next side entry. The rooms are 10 ft. wide and 200 ft. long. The room pillars are 30 ft. wide. The distance between the main and counter levels is 30 ft. and the entry pillars left are 60 ft. in width. The proportion of coal taken in advance work is about 30 per cent. The room pillars have not been pulled. No shooting is done in the mine. No gas has been found in the mine, and open lamps and candles are used.

Ventilation.—The mine is ventilated by a Guibal fan, delivering 8000 cu. ft. of air per minute.

Mine Equipment.—The underground haulage is done by horses. A self-dumping cage is used in the shaft, and the hoisting is done by means of an 18 in. x 30 in. first motion hoist. Two lineal feet of props are used per ton of coal mined. The mine has a capacity of about 800 tons per day, but the actual average is about 75 tons. Fifty per cent of the output is shipped as run-of-mine. There are 18 men employed underground and 6 above ground.

In sizing the coal for market, it is passed over 2-in. and ¾-in. shaking screens, making lump and nut coal. All the coal which passes through a ¾-in. screen—amounting to about 35 per cent—is wasted.

The mine has a track capacity of 6 empty and 16 loaded 30-ton railway cars ; and a storage bin capacity for 100 tons of lump and 40 tons of nut coal. The boiler plant consists of two 100-h.p. return tubular boilers ; one 60-h.p. locomotive boiler and one 20-h.p. vertical boiler.

Humberstone Mine

This mine is situated on a mine spur of the Grand Trunk Pacific railway, 3½ miles from Clover Bar station. The coal seam, which dips about one foot in 24 feet, has an average thickness of about 6 ft. 6 in. It is not broken by faults, but rolls are occasionally met with in the workings.

Method of Mining.—The entrance to the mine is by a shaft 125 ft. deep. The system of mining used is pillar-and-stall. The entries are driven 10 ft. wide and at right angles to the strike. The pillar width between the main and counter entry is 120 ft. Side entries, 8 ft. wide, are driven at right angles to the main entries every 200 ft. The rooms are opened up off the side entries with 60 ft. centres and are driven to meet the corresponding rooms from the next side entry. (See sketch p. 96). The room widths are 15 ft. and the pillar widths, 45 ft. Thirty per cent of the coal is recovered in advance work, and about 70 per cent of the pillars is recovered in retreat. The immediate roof is 4 ft. of shale and, above that, there is 7 ft. of sandstone. The floor is a shaly fire-clay. No gas has been found in the mine, and candles are used for lighting.

Ventilation.—The mine is ventilated by a belt-driven Waddell fan, which, at 100 revolutions, delivers 9000 cu. ft. of air per minute. There are two splits in the ventilation system.

Blasting Methods.—The coal is undermined by compressed-air punch machines and the shooting is done under the supervision of a shotfirer. Black powder and fuse are used for blasting, the tamping material being clay, which is dug in the mine.

The mine has a capacity of 300 tons per day, but the actual average is about 90 tons. There are about 19 men employed underground and 8 above ground.

Mine Equipment.—The tipple is of wooden construction and well equipped with the necessary screens for producing lump and nut sizes of coal. The lump coal consists of coal which has passed over a ⅞-in. bar screen, and the nut coal that which has passed through a ⅞-in. bar screen and has been held on a ¾-in. square-mesh screen.

Thirty-three per cent of the output is shipped as run-of-mine. All coal which has passed through a ¾-in. mesh screen—about 30 per cent of the output—is discarded as waste. During three years' operations about 24,000 tons of coal have been wasted in this way.

The hoisting in the shaft is done by means of a 6 in. x 2 ft. 6 in. first motion hoist. A self-dumping cage is used in the shaft. The haulage underground is by main and tail rope operated by a 10-h.p. engine. The boiler plant consists of one 50-h.p. locomotive type

boiler and a 75-h.p. return tubular boiler. A small air compressor is used for furnishing air for coal cutters of puncher type. In timbering the mine, 4 lineal feet of props are used per ton of coal mined.

Bush Mine

This mine is situated on the Saskatchewan river about one-quarter mile distant from the Humberstone mine. It has no railway connections and the coal is hauled by team to Edmonton for local use. The seam lies flat and ranges in thickness from 5 to 6 feet.

Method of Mining.—The entrance to the mine is by shaft, 38 ft. deep. No power plant has been installed and the hoisting in the shaft is done by means of a horse whim. The system of mining used is pillar-and-stall. The main entry is driven 10 ft. wide and the side entries 6 ft. wide. The side entries are driven 150 ft. apart, and the rooms are driven off the side entries with 29 ft. centres. The rooms are 15 ft. wide and 75 ft. long. The room pillars are 14 ft. in width. The proportion of coal taken out in advance work is about 55 per cent. Some pillars have been drawn, but most of the work is done in advance working.

No gas has been found in the mine, and open lamps are used by the miners.

Blasting Methods.—Blasting is done by black powder and fuse.

The mine has a capacity of about 40 tons per day, but the actual average is about 10 tons. There are 6 men employed underground and 3 above ground.

Ventilation.—Ventilation is secured by natural draft and furnace. In timbering, 4 lineal feet of props are used per ton of coal mined. The coal is screened over 2½-in. and ⅞-in. bar screens, the resulting sizes being lump and nut coal. Twenty per cent of the output is slack coal, which is discarded as waste.

Dawson Coal Company

This mine is situated on the north side of the Saskatchewan river about a mile and a half from Edmonton. It has no railway connection, the coal being hauled to Edmonton by waggons. The seam lies flat and has an average thickness of about 4 ft. 6 in. It is not badly faulted, but rolls are frequent.

Method of Mining.—The entrance to the mine is by a shaft 6 ft. x 6 ft. and 100 ft. deep. The coal is hoisted in the shaft by means of a skip. The hoisting engine is a second motion 8 in. x 12 in. hoist. The system of mining used is pillar-and-stall. The main and side entries are driven 7 ft. wide. The distance between the main and counter level is 40 ft. The rooms are 14 ft. wide and 75 ft. to 80 ft.

long. The room pillars are 28 ft. wide and a pillar 120 ft. wide is left as a barrier pillar at the river. The proportion of coal taken in advance work is about 40 per cent. A large percentage of the pillars is recovered, the total extraction amounting to about 85 per cent.

Blasting Methods.—No gas has been found in the mine, but Wolf safety lamps are used by the miners. The blasting is done by the miners at dinner time and at the end of the shift. Black powder and fuse are used for blasting, and clay dug in the mine is used for tamping material.

Ventilation.—Ventilation is obtained by an improvised fan.

In timbering, 3 lineal feet of props are used per ton of coal mined.

The mine has a capacity of 120 tons per day, but the actual average is about 40 tons. There are 14 men employed underground and 4 above ground.

Mine Equipment.—The tipple is constructed of wood and the coal is sized over 1¾-in. and 1-in. bar screens, the two products being lump and nut coal. The coal which passes through the 1-in. screen is wasted, the waste amounting to about 20 per cent of the output. About two-thirds of the output is shipped as run-of-mine. There is a storage-bin capacity for 60 tons of coal.

The boiler plant consists of one 25-h.p. and one 15-h.p. locomotive type boiler.

Kootenay Formation

While the coal of the Kootenay formation is chiefly bituminous, it has been altered to anthracite in the Cascade basin, the greatest alteration being found near Banff. This basin has been estimated to contain 400,000,000 tons of anthracite and 1,200,000,000 tons of the softer grades of coal. The mines operating in this area are situated at Bankhead and Canmore.

Bankhead Mines

The mine is situated in the Rocky Mountains Park on the Cascade river, five miles east of Banff. A branch line, two and one-half miles in length, connects it with the main line of the Canadian Pacific railway at Bankhead junction. Eleven coal seams have been found on this property; five of them are being worked at present, two are known to be workable, while the other four have not been thoroughly prospected. The general strike of the seams is N. 20° W., the dip varying between 50° and 30° west.

The following table and accompanying section, give the position and thickness of the seams as obtained from a section at No. 30 manway, No. 2 seam :

COAL SEAMS, BANKHEAD MINES

Seam	Thickness	True thickness of intervening strata	Remarks
No. 0	4 ft.	33 ft. to No. 1 seam	A workable seam, but not worked.
1	10 "	30 " " " 2 "	A workable seam, but not worked.
2	8 "	110 " " " 3 "	Being worked
3	10 "	215 " " " 3½"	" "
4	12 ft. 6 in.*	75 " " " 5 "	" "
5	8 "	140 " " " 6 "	" "
6	8 "	45 " " " 7 "	" "
7	—	90 " " " 8 "	
8	—	80 " " " 9 "	Have not been prospected
9	—	187 " " " 10 "	
10	—	19 " " " 11 "	
11	—		

The entrance to the mine is by tunnel 5,000 ft. long, having a double track, with manway in between. The tunnel is driven in gravel for 1,200 ft. to intersection with No. 2 seam. Eleven seams are intersected by it at an angle of about 45°, and have been more or less developed. No. 2 seam has been most extensively developed, both from the main tunnel and the old entry, which latter is at a higher level. Nos. 4, 5 and 6 have been developed by the main tunnel and by B level. (See section, p. 112).

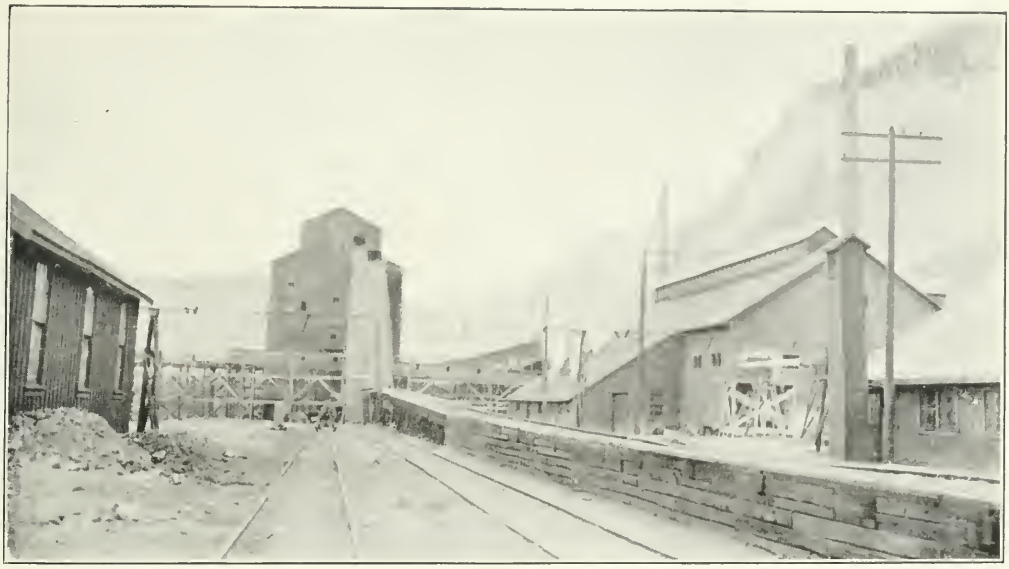
Method of Mining.—The system of mining is pillar-and-room. The old practice was to drive the rooms 20 ft. wide and leave 30-foot pillars, but the present practice is to drive the rooms 10 ft. wide and leave 40-foot pillars. The chutes are turned off at such an angle from the counter gangway as to give them an inclination of 30°. Crosscuts, 8 ft. in width, are driven through the room pillars, in steps, 60 ft. apart.

Gas has been found in the mine and Wolf safety lamps are used by the miners.

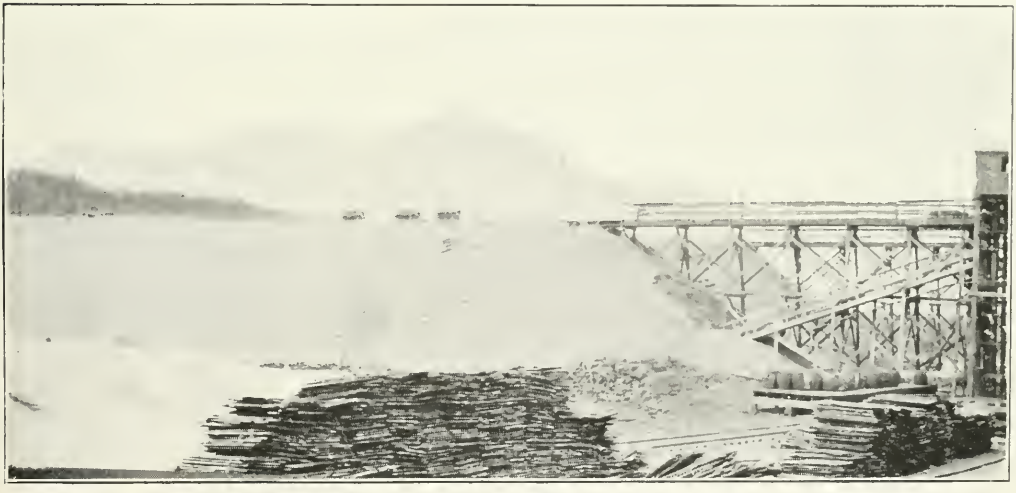
Blasting Methods.—The blasting is done by means of fuse, No. 6 detonators and Monobel powder. A Bickford igniter is used for igniting the fuse. Fire-bosses only, are allowed to have detonators in their possession. Sampsonite† is used for brushing the roof or floor. The tamping material used is clay, which is both dug in the mine and sent in for that purpose.

*The seam is split up into a 9-ft. seam and 3½-ft. seam by a parting 2 ft. in thickness.

†Permitted explosive.



Power House and Bankhead, Bankhead Mines, Ltd.



Slack Coal Dump, Bankhead Mines, Ltd.
Photograph shows a conveyer installed during a strike to carry the slack coal to the briquetting plant.

The mine is ventilated by means of a rope-driven Capell fan delivering 170,000 cu. ft. of air per minute with a water gauge of 2 inches.

Mine Equipment.—The haulage in the mine is done by compressed-air locomotives, the equipment being two Rand, 12-tons; two Porter, 7½-tons ; and 3 Porter, 5-tons ; all operated by air at 1,000 lbs. pressure.

The power plant consists of :

(*a*) Two cross-compound condensing engines, direct coupled to two 150-k.w. generators. The electric power is generated at 2,200 volts, and is used for lighting the town and works, as well as the town of Banff. It is transformed to 6,600 volts for transmission to Banff, but stepped down to 220 volts for local use.

(*b*) Two low-pressure, cross-compound air compressors ; steam cylinders 16 in. and 30 in. by 36-in. stroke ; air cylinders 17 in. and 28 in. by 36-in. stroke. The air is compressed to 120 lbs. per square inch at 80 r.p.m. and is used for operating pumps and drills and improving the ventilation.

(*c*) One high-pressure, four-stage cross-compound air compressor ; steam cylinders 18 in. and 34 in. by 36-in. stroke ; air cylinders ; first stage 22 in.; second stage 12½ in.; third stage 10 in.; fourth stage 5½ in.

The boiler plant consists of nine 150-h.p. return tubular boilers with feed-water heaters and purifiers, and induced draft fans.

The water supply from May to November is obtained from a reservoir on the creek, by a 6-in. pipe under a head of 300 ft. For the remaining months of the year, it is pumped from the river by a tandem pump of 500 gals. capacity. A second pump of the same capacity is reserved for use in case of fire.

To prepare anthracite coal for the market it is necessary to remove the dust and impurities and separate it into different sizes. The following sizes, with the percentage of output obtained at the mine, are produced :

CLASSIFICATION OF ANTHRACITE OUTPUT—BANKHEAD MINES

Name	Size		Per cent of output
	Through	Over	
Broken	3-in. bar	3¼-in. round holes	10.0
Egg	3¼-in. holes	2¼-in. " "	3.0
Stove	2¼-in. "	1½-in. " "	3.5
Nut	1½-in. "	1-in. " "	6.5
Pea	1-in. "	9/16-in. " "	8.0
Buckwheat No. 1	9/16-in. "	5/16-in. " "	6.0
" No. 2	5/16-in. "	¼-in. " "	5.0
" No. 3	¼-in. "	⅛-in. " "	9.0
Dust	⅛-in. "		35.0
Rock			14.0

The company finds a market for all these sizes, with the exception of No. 3 buckwheat, which is used under the boilers. The dust is made into briquettes in the briquetting plant.

Breaker.—In a paper presented to the Canadian Mining Institute,* Messrs. Lewis Stockett and B. R. Warden give the following description of the breaker :

An endless chain, with hooks engaging the axles of mine cars, lifts them by incline to the top of the breaker, 100 feet above the railway tracks. The capacity of this chain is two cars of two tons each per minute, which can be increased, when desired, by decreasing the space between the hooks. Another endless chain returns the empties down the incline. The travel of the car is automatic from the time it leaves the uphaul chain, passes over the tipple, and reaches its destination at the bottom. Being weighed in passage, cars dump into a chute, and the coal is regularly fed by automatic feeders, over screen bars with three-inch space, delivering to a platform on which the over-size is sorted, rock and slate going to the rock bin, clean coal through a set of rolls, to be broken up to marketable sizes, and that portion which contains bone or slate is sent to another set of rolls to be broken. We thus have three streams of coal, which are kept separate for different treatment,—clean coal, slaty coal, and undersize, which is mixed. Pure coal needs only screening and sizing. Bony coal requires this, and also thorough cleaning. Broken and egg size pass through a screen on to a picking belt, from which impurities are removed by hand picking, rock and slate being conveyed to the rock bin, and mixed coal and slate to rolls to be further broken. The coal below egg is elevated to the top of the building and passes over another set of screens, being separated into stove, nut, pea, buckwheat Nos. 1, 2 and 3, and dust. The stove coal is treated on a mechanical device known as the Emery picker, coal and slate being conveyed to their separate destinations, and while so conveyed being picked again by hand to remove slate from the coal, or coal from the slate which has been missed by the machine. Nut and pea coals are similarly treated, with the exception that, in the case of pea size, no attempt is made at hand picking. No. 1 buckwheat passes over Slater bars, which by removing the flat pieces, clean the coal with comparatively little loss. No. 2 buckwheat is sufficiently clean to go direct to the bin. Mine-run of coal, which passes through the grizzly, receives a double treatment in perforated chutes to eventually remove the dust and to separate the broken size. The broken size joins a broken size from the bony coal stream on the picking belt. Egg size

* *Transactions, Canadian Mining Institute*, Vol. IX., 1906.

is dealt with similarly, and the remainder is elevated to the top of the building for a like treatment to that of the bony coal with the exception that, as it contains a large proportion of impurities, it has double the number of pickers ; both machine and hand, and nut and pea sizes pass over Slater bars to remove the flat pieces. Shaking screens are built of steel belt and angle irons suspended on a ⅝-inch chain, actuated by eccentrics. The pitch of the screens is two inches per foot. Elevators are of the continuous discharge type, with deflecting shafts, giving a more perfect discharge. The combined elevating capacity of the three elevators is 2,700 tons per day of 10 hours.

Without going into detail of the machinery equipment and its arrangement, it is sufficient to say that all is of the best design and workmanship, and economy of handling has been studied with good effect. From the bins, coal is drawn through gates to a belt conveyer, 36 inches wide, running the full length of the building, at a speed of 150 feet per minute, which conveys to a lip screen set at an incline, with different sized perforations. This takes out any dust, and it ensures sizing before it passes to be loaded on open cars by chute, or into box cars by the box-car loader. Slate, and other refuse, from the various picking machines, slide by gravity into a flight conveyer, which delivers to the dump. The box-car loader is a Victor, operated by its own engine, with steam from the main boiler plant. Power is furnished for the breaker by a 16 in. x 28 in. x 36 in. cross-compound horizontal engine, running at 100 revolutions per minute, using steam at 120 lbs. pressure, in a high pressure cylinder, and capable of developing 300 horse-power. All long drives are of 1½-inch manilla rope. For short drives, rubber belting is used. Main lines of shafting run at 100 revolutions per minute, from which the required speeds are developed. The foundations of the building and machinery are all concrete, timber is Douglas fir, and framing is done without the use of mortice and tenon, being continuous posts spliced together, with cross timber, braces, etc., bolted on, wooden braces giving further support if necessary. This, the engineers claim, gives a more lasting structure, with less vibration from the machinery, or from high winds which prevail. The building is heated by steam, some 5,000 feet of 2-inch pipe being used for that purpose. Two hundred 16-candle-power incandescent electric lights furnish lights for the building. For fire protection there are two hydrants on the outside of the building, supplied by water under 400 feet of head, also two sand pipes, one at either end of the building, with hose connection at three floors. Fire buckets in convenient racks are always full of water and ready for use. Duplicate parts of all machinery liable to break or wear are conveniently at hand.

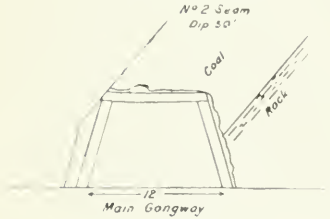
Briquetting Plant.—The briquetting plant consists of two units having a capacity of 500 tons in 24 hours. Each unit is run by a 14 in. x 20 in. duplex steam engine, but using only one pitch tank for feeding the mixers.

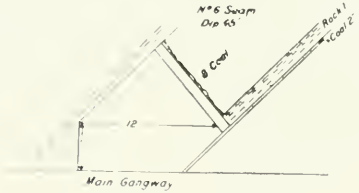
The dust resulting from the mining and sizing of the coal, constituting 35 per cent of the output, is conveyed from the breaker dust-bin by means of a scraper conveyer, to the dust-bin in the briquette plant, and is fed from the bin to the rolls by means of an automatic feed. It then passes through the crusher and is elevated to the mixers, of which there are six placed at right angles to each other in each unit. The mixers consist of 2½ ft. x 2½ ft. brick flues in which shafts with deflecting arms rotate at such a speed as to keep the coal in suspension above the centre of the shaft. The products of combustion from a Black heater are passed directly through the coal dust in the mixers. In mixers 1, 2 and 3, the dust is dried and heated to the temperature of about 300° Fahrenheit. At the lower end of No. 3 mixer, the pitch is introduced by means of an atomizer. This pitch vapour, passing through the cloud of dried and heated coal, coats each particle evenly. No. 5 mixer is used to heap up and spread any pitch bails that may be formed. No. 6 mixer is used for cooling. From No. 6 mixer the material is elevated to the press-hopper and briquetted in the press. The press has a briquetting roll, the surfaces of which are made of discs forming pillow-shaped briquettes. One unit of the briquetting plant makes briquettes 2⅛in. square by 1⅜in. thick in the centre. The other unit makes briquettes 4½in. by 2⅛in by 1⅜in. thick in the centre.

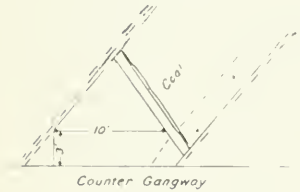
From the press the briquettes are carried by belt-conveyers to the distributor over the cooling-table. They are carried back and forth the length of the table for about one hour, and are then dropped into the briquette-conveyer, which carries them to the briquette-bins in the breaker. From these bins they are loaded into railway cars.

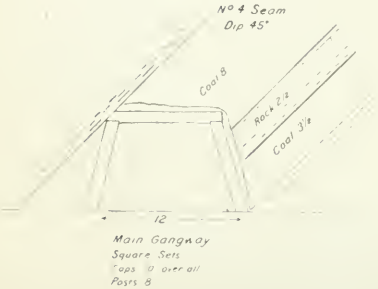
The pitch used in the plant is by-product pitch obtained from coke ovens. It costs $17.50 per ton at the mine, and is brought from Sault Ste. Marie, Ont., in tank cars fitted with steam pipes so that they can be heated to facilitate discharge. The pitch-car is delivered on the siding just above the pitch tanks, and, by connecting the car with a steam pipe, the tar is heated and flows by gravity down a steam-heated trough to the pitch-house. The pitch-house contains two tanks, 14 ft. by 7 ft. and 10 ft. deep, which are heated by steam coils. The tar is pumped from the bottom of the tanks by centrifugal pumps and delivered to the pitch-tank in the briquetting plant.

COMMISSION OF CONSERVATION









METHODS OF TIMBERING GANGWAYS,
BANKHEAD MINE

SKETCH OF ANGLE WORKINGS, BANKHEAD MINE

From the above description of the plant, it can be seen that the operations are continuous and are performed mechanically throughout, thereby effecting economy in labour and maintaining a maximum output.

During March, 1911, the company produced 12,165 tons of briquettes. It is reported that the average cost of production is about $3.10 per ton, allowing $1.00 for the cost of the dust. From 8.5 to 9.5 per cent of tar is added as a binder in making the briquettes.

The plant is equipped with the following storage bins :

Broken	222 tons
Stove	220 "
Nut	220 "
Briquettes	223 "
Pea	211 "
No. 1 Buckwheat	230 "
No. 2 Buckwheat	228 "

The mine has a capacity of 1,500 tons per day, but the actual average is about 1,200 tons. There are 275 men employed underground and 155 men, including 40 Chinamen, above ground.

Canmore Coal Company

This Company is operating two mines—No. 1 and No. 2—in the Cascade Coal basin near Canmore, a station on the Canadian Pacific ry., fifteen miles southeast of Banff.

Eight seams have been prospected on the property, but the Sedlock, Carey, No. 1, No. 3, and No. 4 seams are the principal ones worked at the present time. The coal is semi-anthracitic in character, and is a very good steam coal. The seams are frequently folded and faulted. The sections, facing page 126, show the relation of the various seams to one another and also the major folds in this area.

No. 1 Mine

This mine is situated on the right bank of the Bow river west of, and adjoining, the town of Canmore. A spur line about three-quarters of a mile in length connects it with the Canadian Pacific railway.

The Carey seam is the principal one worked, although some coal is obtained from No. 3 seam. It has an average thickness of about 7 ft., and the dip varies from flat to vertical. The entrance to the mine is by No. 1 main slope, 620 ft. in length, driven on the dip of No. 2 seam. A crosscut tunnel connects the slope with the main haulage level on No. 3 seam. The haulage level, 12 ft. wide, is driven partly in No. 2 and partly in No. 3 seam and is well timbered with round sets. About 3,200 ft. from the slope, No. 5 tunnel is driven to

the Carey seam. No. 6 tunnel is driven from the haulage level 1,800 ft. east of No. 5 tunnel and the workings from this connect with No. 5 workings on the west and extend for 3,200 ft. on the east. No. 3 seam varies from 5 ft. to 8 ft. in thickness. It is developed by a slope, 1,000 ft. in length, driven from the main haulage level 600 ft. east of No. 1 main slope. There are two levels about 56 ft. apart, opened off this slope.

Method of Mining.—The system of mining is pillar-and-room. Double chutes are driven up the pitch from the levels every 200 ft. Rooms, 12 ft. wide, are driven from the chutes across the pitch every 42 feet, centre to centre. As soon as all the rooms between a pair of chutes are driven, the pillars are drawn by commencing at the top of a chute and removing the upper pillars a little in advance of the lower.

Practically all the pillars are recovered, but about 12 per cent of the coal is gobbed in the mine on account of impurities getting mixed with it. The roof is calcareous sandstone with about one foot of drawn slate immediately over the coal. The floor is calcareous sandstone.

Blasting Methods.—Blasting is done at any time under the supervision of shotfirers. Monobel powder, No. 7 detonators and battery, are used for blasting. Sampsonite powder is used for rock work. Clay for tamping is sent into the mine.

Gas has been found in the mine and Wolf and bonneted Clanny safety lamps are used exclusively underground.

Haulage.—The haulage on the main slope is by first-motion steam engine, diameter of cylinder 22 in. by 36-in. stroke. The diameter of the drive is 6 ft. and the hoisting rope is 1¼ in. in diameter.

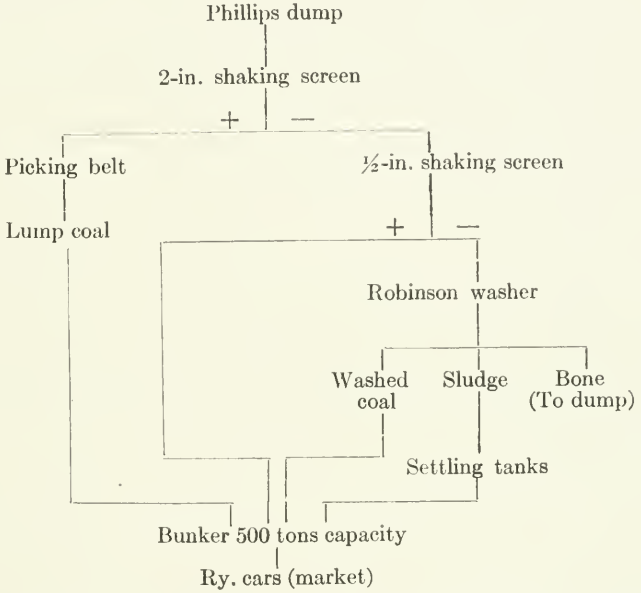
The haulage on the main level to No. 5 tunnel is by a compound air locomotive, with cylinders 6½ in. and 11 in. by 10-in. stroke. Two smaller air locomotives and horse haulage are used in the other portions of the mine. A 10 in. by 14 in. second-motion hoist is now being installed at the top of No. 3 seam slope.

Ventilation.—The mine is ventilated by a Capell fan, 8 ft. in diameter, belt-driven from a 16 in. by 18 in. steam engine. It is used as a force fan and delivers 90,000 cu. ft. of air per minute. There are ten splits in the ventilating system.

Timbering.—The gangways, chutes and rooms are well timbered with full sets. The method of timbering used is a boom and two posts and a boom and three posts. In the latter case, the post and boom are placed in a hitch cut out of the lower rib.

About 2½ lineal feet of props are used per ton of coal mined.

Output.—The mine has an average output of about 650 tons of coal per day. There are 200 men employed underground and 70 above ground. The coal is shipped as run-of-mine which has been previously picked and washed. The following is an outline of the washing and picking operations.



Mine Equipment.—The boiler plant consists of five 125-h.p. return tubular boilers and one 175-h.p. flue boiler.

The power plant consists of one air-compressor, the diameter of the air cylinders being 21 in. and 33 in., while the diameter of the steam cylinders is 20 in. and the stroke is 36 in. This compressor furnishes air for hoisting, pumping and operating machine drills underground.

A four-stage high-pressure air-compressor is used to furnish air for locomotive haulage.

The diameters of the air cylinders are :

1st stage.....	18 in.
2nd "	10½ in.
3rd "	9 in.
4th "	5 in.

The diameter of the steam cylinders is 16 in., and the stroke is 24 in.

The tipple and washery are operated by a 14 in. by 16 in. steam engine.

A steam engine, 12 in. by 16 in., operates the shaking screens and conveyers at the tipple and bunkers. The mine is well equipped with

carpenter, machine and blacksmith shops for doing ordinary mine repair work.

No. 2 Mine

This mine is situated about half a mile to the south of No. 1 mine, and is connected with it by a railway spur.

The principal coal seam worked is the Sedlock, which has an average thickness of 5 ft., although about 150 tons per day are obtained from the Carey seam. The measures are folded and form a spoon-shaped basin which is tapped by the main slope. They then rise for a short distance and form a dipping synclinal fold.

The mine has been opened up by a slope 1,000 ft. in length sunk on the Sedlock seam and driven to the bottom of the basin. A back balance 500 ft. in length, connects the main slope haulage with No. 1 contour level. This level is about 3400 ft. in length and forms a U with the concave end away from the slope. The coal dips about 4° on each side of the slope, and 8° to the rise of the level. The seam splits in the basin to the south of the contour level. The following is an approximate section :

Coal	3 ft.
Rock	2 ft.
Coal	2½ ft.

The coal in this basin is being opened up by a basin slope 600 ft. in length, and the top coal only is mined. About 150 ft. east of the bottom of the main slope a crosscut tunnel 400 ft. in length is driven to the Carey seam. It cuts the Carey about 20 ft. below the evel of the flat and where the measures are undulating. About 150 tons per day are obtained from the workings on this flat.

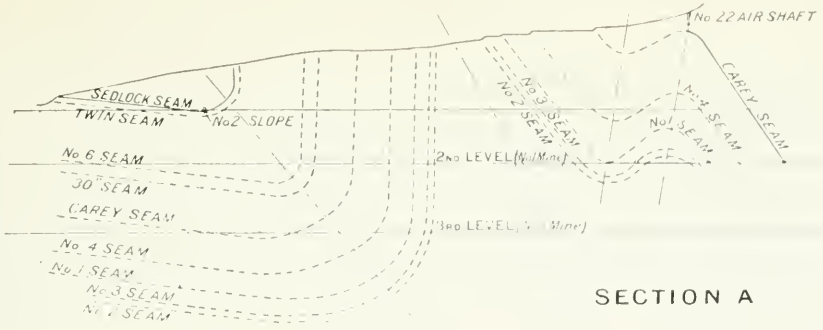
Method of Mining.—The system of mining is pillar-and-room. Jigs, 30 ft. in width, are driven up the pitch, 120 ft. apart. Rooms, 30 ft. in width, are opened off the jigs and driven across the pitch every 60 ft., centre to centre.

Blasting and Timbering Methods.—The same blasting and timbering methods are employed as described under No. 1 Mine.

Haulage.—The haulage on the main slope is by slope engine, six cars being hoisted at one time. A 14 in. by 18 in. second-motion hoist is used for haulage on the basin slope ; the diameter of drum is 6 ft. and of the rope ¾ in.

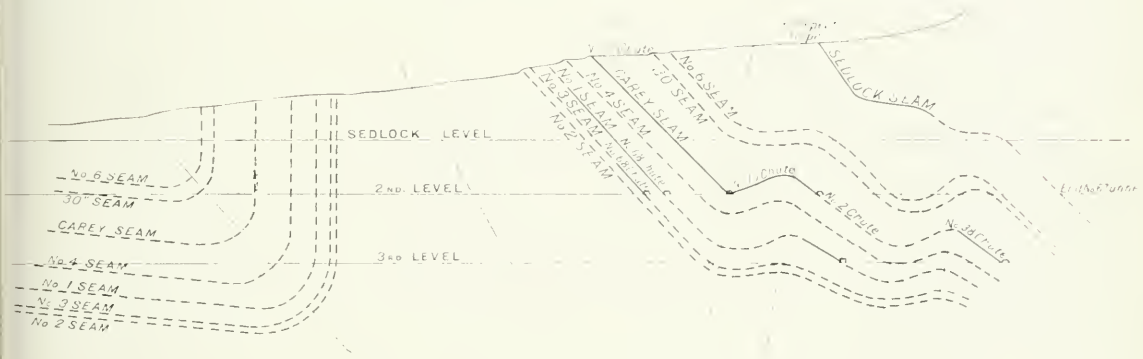
Horse haulage is used on all levels.

Ventilation.—The mine is ventilated by a Guibal fan, belt-driven from a 10 in. by 14 in. steam engine. It is used as a force fan

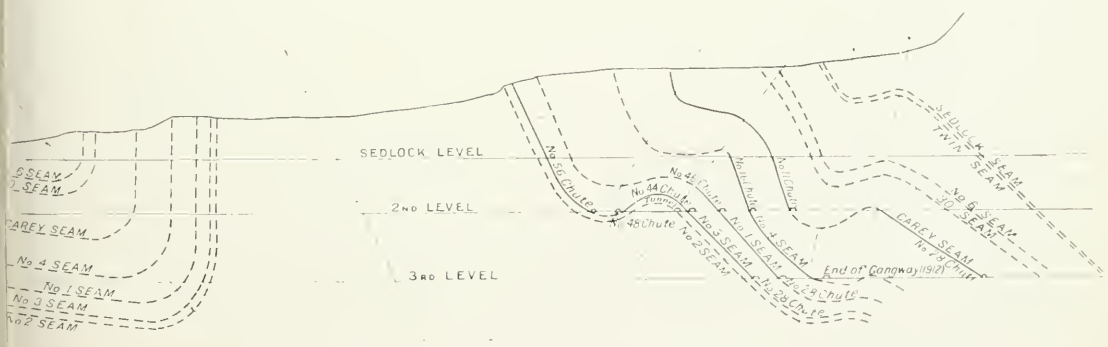


SECTION A

SECTION B



SECTION C



VERTICAL SECTIONS THROUGH COAL MEASURES, CANMORE

SECTION A, SECTION B, AND SECTION C, ARE PARALLEL TO ONE ANOTHER AND 1,000 FEET APART. THE STRIKE OF EACH SECTION IS S. 60° W.

Scale – 700 Feet = 1 Inch

and delivers 60,000 cu. ft. of air per minute. There are four main splits in the ventilation system.

Output.—The mine has an average output of about 400 tons per day. There are 200 men employed underground and 40 above ground. The coal is shipped as run-of-mine which has been previously screened, and picked. The screening operations are similar to those described under No. 1 Mine.

Mine Equipment.—The boiler plant consists of two 150-h.p. return tubular boilers.

Compressed air for pumping and mine haulage is supplied from No. 1 Mine.

A 150-h.p. steam engine operates the picking and screening machinery on the bankhead.

The International Coal and Coke Company

This mine is situated at Coleman, on the Crowsnest branch of the Canadian Pacific ry. There are six seams in this property, but the company are at present mining coal from only two of them, No. 2 and No. 4. The thickness of the seams is as follows :

No. 1..... 10 in.
No. 2.....17 ft. 4 in. with an average of 14½ ft.
No. 3..... 2 ft. 2 in.
No. 4..... 7 ft. 2 in.
No. 5..... 2 ft. 6 in.
No. 6.....17 ft. soft coal with bands of slate.
Total.....47 ft.

The strike is approximately north-and-south ; dip, 32°.

The seams are not badly faulted and the roof and pavement are smooth and regular. The roof, over No. 2 seam, is sandstone, and, in the roof of No. 4, there is about 2 ft. of drawn slate. The floor is soft and scaly.

The following are sections taken in the rooms of No. 2 and No. 4 seams :

No. 2—
Hard coal.....1 ft.
Soft coal.....4 ft. 9 in.
Coal and dirt .....1 ft. 6 in.
Bone coal.....1 ft. 6 in.
Soft coal.....5 ft. 6 in.
Hard coal.....3 ft. 1 in.

No. 4—
Hard coal.....8 in.
Soft coal.....6 ft. 6 in.

In No. 2 seam, the coal is undercut in the top and, in No. 4 seam, it is undercut in the floor. The two seams are opened up by means of two separate tunnels which unite at the tipple. The main entry in No. 2 seam has been driven for a distance of 12,300 ft., and No. 4 entry is 8,600 ft. long. Eighty feet of strata separate No. 2 from No. 4.

Method of Mining.—The general method of working is to keep the development work on the upper seam (No. 2) in advance of the lower. In this way, it is possible to withdraw the pillars from the upper seam and allow the roof to settle before the pillars are removed from the lower.

The mine is worked in a most systematic manner and the extraction from both seams is very high. The system of mining adopted is pillar-and-stall, with barrier pillars. (See sketch facing page 130).

The chutes or rooms are driven up the pitch every 60 feet. After ten chutes have been driven, one chute is omitted, leaving a barrier pillar 110 ft. wide. These barrier pillars divide the mine into panels 600 ft. in width. Every tenth room is carried through from entry to the surface, for the purpose of aiding ventilation and serving as a timber chute. The chutes vary in length up to 1,200 ft., are driven 10 ft. wide and continued to the surface. After all the chutes in a panel have been driven, the pillars are removed. The pillars are removed from the surface towards the entry, but three rows above the entry are not withdrawn, but left to support the main entry. In removing them, the pillar is first attacked by widening out the chute on one side just below the last cross-cut. It is then sliced diagonally and the coal allowed to slide down the chute. Where the roof has fallen after the pillar has been removed above, a battery is placed between one side of the chute and the top of the pillar which is being withdrawn. In this way, the rock is prevented from rolling down upon the workmen and crashing down the chute to the entry below. In withdrawing pillars, only one row is withdrawn from each chute.

Very little timber is used in the mine: in No. 2 seam, three-quarters of a lineal foot of props is used per ton of coal mined ; in No. 4 one and one-quarter lineal feet is used per ton mined.

The coal is hauled from the chutes on the main entry to the tipple by means of compressed-air locomotives. In order to get a sufficient height for screening the coal, the mine cars are hoisted 98 ft. to the top of the tipple by means of a steam hoist and self-dumping cage. Eighty per cent of the output is shipped as run-of-mine and the rest (slack) goes to a Bradford breaker and is delivered to the coke ovens. The coal is picked on picking belts.

Blasting.—Very little powder is used in the mine, but, when blasting, No. 6 detonators and Monobel powder are used.

Ventilation.—The mine is ventilated by an 11 ft. x 7 ft. Capell fan and a 10 ft. Sullivan fan.

It has a capacity of 2,300 tons per day of 10 hours, but the actual average is about 2,000 tons. There are 375 men employed underground and 175 above ground.

Mine Equipment.—The boiler plant consists of ten return tubular boilers, 18 ft. long by 6 ft. wide, aggregating 1,300 h.p. The mine locomotives consist of four compound and six simple compressed-air locomotives. The power plant consists of two 250-k.w. direct current generators driven by two steam engines, size of cylinders 24 in. x 18 in.

The air compressors consist of one duplex air compressor, with cylinders 14 in. in diameter by 22 in. stroke, with a capacity of 1,160 cu. ft. of free air per minute; and two four-stage, high-pressure compressors having a capacity of 776 cubic feet of free air per minute. One ventilating fan is driven by a 150-h.p. motor ; the other by a 14 in. x 16 in. steam engine. One 75-h.p. steam hoist is used to hoist the coal to the top of the tipple. Two electric motors are used for operating the tipple machinery. Two 35-horse-power electric lorries are used for charging the coke ovens.

The machine shop is equipped to do ordinary mine-repair work and consists of three lathes, drill presses, shapers and pipe-threading machines. The blacksmith shop has two forges and a steam-hammer. The carpenter shop is equipped with band and cross-cut saws.

Coke Ovens.—The coke ovens, numbering 216, are of the beehive type, 14 ft. in diameter. They take a charge of 6½ tons of slack, and have a total output of about 400 tons per day. The coal from No. 4 seam makes an excellent coke. That from No. 2 is of inferior quality, but, by mixing the coal of the two seams in equal parts, a very satisfactory coke is obtained.

The mine has a storage-bin capacity for 400 tons of coal and 300 tons of coke, and a track capacity of 75 empty railway cars and 60 loaded cars.

McGillivray Creek Coal and Coke Company

This mine is situated at Carbondale, near Coleman, and is connected by an electric railway line with the Crowsnest branch of the Canadian Pacific ry.

There are two seams of coal separated by about 100 feet of strata, but only the lower one, No. 2, is being worked. The average thickness of this seam is about 9½ feet. The seams have a strike of N. 7° W.,

a dip of 30° to the west, and are occasionally broken by upthrow and downthrow faults of small magnitude.

Method of Mining.—The entrance to the mine is by a slope 280 ft. long. The system of mining is pillar-and-stall, the stalls really being chutes driven up the pitch. The chutes vary in length up to 550 ft. The main entry is driven 11 ft. wide and the rooms 8 ft. wide. Crosscuts, 8 ft. x 8 ft. are driven every 60 feet. The room pillars are 50 ft. wide.

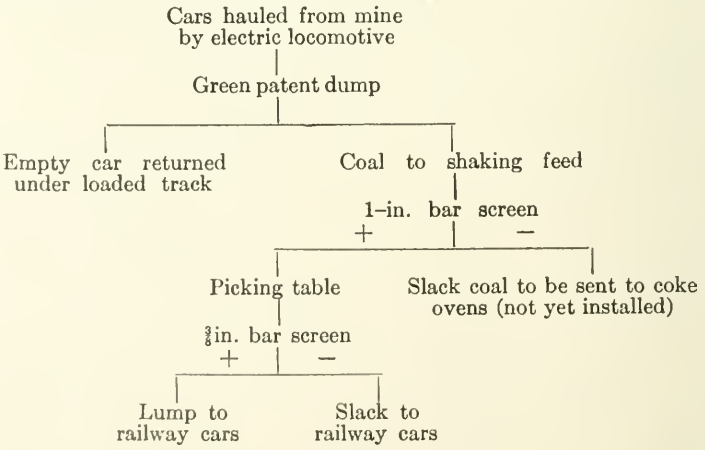
No gas has been found in the mine, but Wolf safety lamps are used exclusively underground.

Blasting Methods.—The blasting is done under the supervision of a shotfirer by means of a battery and Monobel powder. There are three shotfirers on each shift. The tamping material is clay, which is sent into the mine for that purpose. The roof is shale, with a cap rock of shale from 1 in. to 3 in. in thickness. The floor is smooth and hard.

Ventilation.—The mine is ventilated by means of a Sirocco fan used as a force fan, delivering 45,000 cu. ft. of air per minute, with a water gauge of 1 inch.

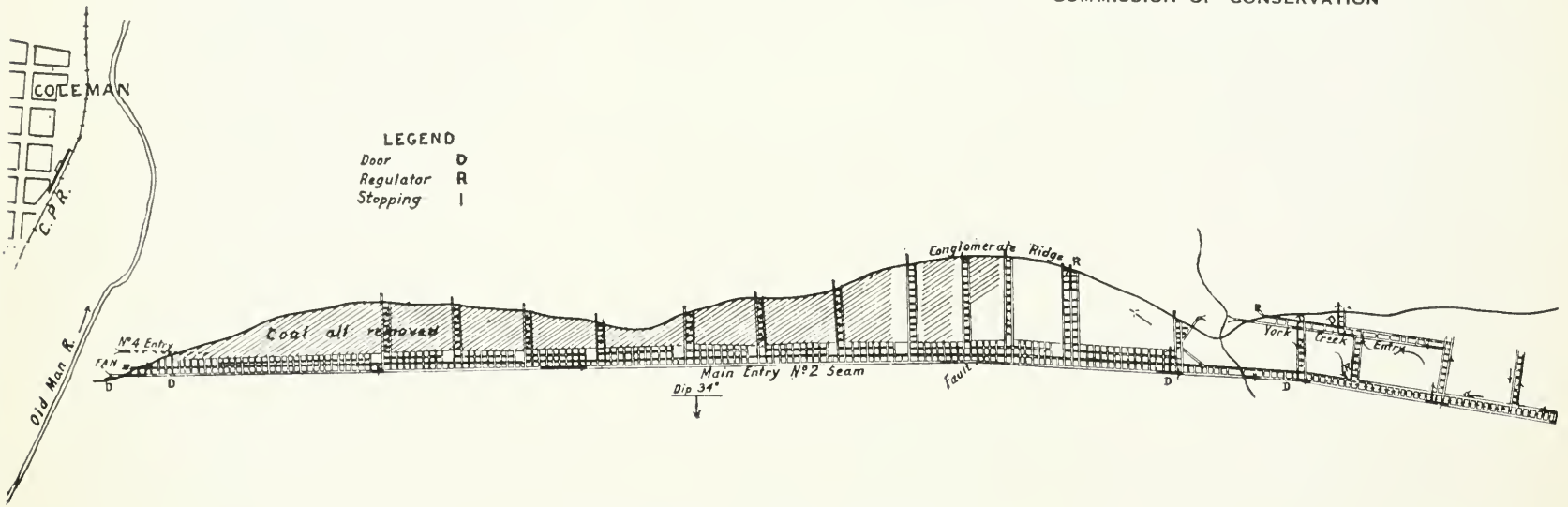
The mine has a capacity of 2,000 tons per day, but the actual average is about 400 tons. There are about 70 men employed underground and 25 above ground.

Mine Equipment.—The coal is hauled from the mine to the steel tipple, a distance of nearly two miles, by means of two 100-h.p. electric locomotives operating on a rack rail. The tipple is well constructed to handle a large output. The following gives the tipple flow-sheet :



The box cars are loaded by means of an Ottumwa box-car loader.

The boiler plant consists of one 40-h.p. and one 30-h.p. boiler situated at the mine, and two 150-h.p. boilers situated at the power



PLAN OF No. 2 SEAM WORKINGS,
INTERNATIONAL COAL & COKE CO., COLEMAN, ALTA.

house at the tipple. The power house consists of a 150-k.w., 550-amperes, 250-volts generator, driven direct by an 18 in. x 18 in., 267-h.p. steam engine. The electricity generated is used for supplying power for locomotives, tipple and machine shop, and for lighting purposes.

Canadian Coal Consolidated

This mine is situated at Frank, on the Crowsnest branch of the Canadian Pacific ry. The coal seam has a strike of N. 35° W., and the dip varies from 30° to vertical. The thickness varies from 10 ft. to 25 ft., but the average thickness is about 12 ft. It is frequently faulted and rolls are often met with in the workings.

The company is operating what might be called two separate mines, the Old mine and the Shaft mine.

Old Mine

The entrance to this mine is by a main gangway about two miles in length. In places the coal has been mined out from the gangway to the surface. The system of mining previously followed was to drive "chestnut" chutes off the main gangway. The coal is hauled from the main gangway to the bankhead by means of main and tail rope.

Shaft Mine

Method of Mining.—The shaft is about 330 ft. deep, with levels at 120 ft. and 220 ft. from the surface. This mine has been worked on a breast system, or, what is really a longwall system, on a nearly vertical seam. About 75 per cent of the coal was extracted in this way, but the danger of the small pillars dropping down has forced its abandonment. This method was changed and the mines worked on an angle or diamond system, with rooms 6 ft. x 6 ft. and diamond pillars 30 ft. in width.

At Frank, lack of system in mining has resulted in the permanent loss of large areas of coal. Chestnut chutes have been driven up the pitch and the pillars drawn at random. Thus it is impossible to recover economically the large blocks of coal that have been left between areas where pillars have been removed.

It is stated that, in the breast work at the Shaft seam, a recovery of 75 per cent has been obtained, but, considering the area attacked, not more than 10 per cent of the coal has been recovered. This state of affairs is attributable, to a large extent, to the numerous changes of management which have taken place in the past. Portions of the old workings have been on fire.

Gas has been found in the mine and Wolf safety lamps are used everywhere above the level of the main gangway. The pump-house in the mine is lighted by electricity.

Blasting Methods.—The blasting is done under the supervision of shotfirers, Monobel powder and No. 6½ detonators being used. Forty per cent dynamite is used in rock work and for brushing the roof and floor.

Ventilation.—The Old mine is ventilated by a Capell fan, and the Shaft mine by a small Murphy fan.

Three lineal feet of props per ton of coal mined are used for timbering.

Mine Equipment.—The boiler plant consists of six 250-h.p. water-tube boilers, and two condemned water-tube boilers.

The power plant consists of one 400-k.w., a.c. generator, direct-driven by a 24 in. and 36 in. x 24 in. cross-compound steam engine, which is used to generate power for lighting, pumping and ventilating purposes ; and one 40-k.w., a.c. generator, belt-driven from a 14 in. x 15 in. steam engine. One 100-k.w., a.c. generator, belt-driven from a 14 in. x 15 in. steam engine, generates power for pumping purposes ; and three low-pressure Ingersoll air compressors furnish power for coal cutting. The mine has a bunker capacity for 1,700 tons of coal. It has a capacity of 450 tons per day, but the actual average is about 380 tons. The total output is shipped as run-of-mine.

Leitch Collieries

This company is at present operating two collieries, No 1 South and No. 2 North.

No. 1 South Mine

The mine is situated south of the Crowsnest branch of the Canadian Pacific ry. near Passburg, Alberta. The seam has an average thickness of 6 ft. and dips 63° to the east. No other seams have been found.

The entrance to the mine is by a 3,000-ft. tunnel driven from the outcrop. The system of mining used is pillar-and-stall. Rooms 40 ft. wide are driven from the counter level up the pitch. The room pillars are 15 ft. wide and crosscuts are driven through the pillars every 50 ft.

Two crosscuts are driven from the main and counter entry to each room. A 20-ft. pillar is left to protect the counter level. In driving the rooms up such a steep pitch, the men stand on the coal while working. In order to ventilate the room properly, the man-way and air-way are kept open to the face. The room pillars have not been drawn.

The output, 250 tons per day, is picked and shipped as run-of-mine. There are 60 men employed underground and 20 above ground. In timbering, 6 lineal feet of props are used per ton of coal mined.

No. 2 North Mine

The mine tipple is situated on a spur line of the Crowsnest branch of the Canadian Pacific ry. three-quarters of a mile east of Passburg station. A gravity plane, 2,000 ft. in length, connects the mine with the tipple.

Four coal seams have been prospected on the property :

Seam No.	Thickness	Distance (along pitch) to next seam	Remarks
1	6 ft.	100 ft.	A dirty coal
2	7 "	25 "	Being worked
3	5 "	43 "	Clean coal
4	5½ft.	—	Clean coal, being worked.

The strike is approximately north-and-south ; the dip, 60° W.

Method of Mining.—The entrance to the mine is by a tunnel 2,400 ft. in length, driven from the outcrop. The system of mining used is pillar-and-stall. The main entry width is 10 ft. A pillar 35 ft. in width is left between the main and counter levels. A portion of the mine has been worked with stalls driven up the pitch, but the present practice is to work across the pitch. The rooms are driven 20 ft. wide and vary in length from 250 ft. to 500 ft. depending on whether they are driven across or up the pitch. The room pillars are 20 ft. wide and crosscuts are driven through the pillars for ventilation every 50 ft. No pillars have been pulled and the extraction is about 55 per cent. The roof is sandstone and the floor, hard sandy shale. Gas has been found in the mine and Wolf safety lamps are used exclusively underground.

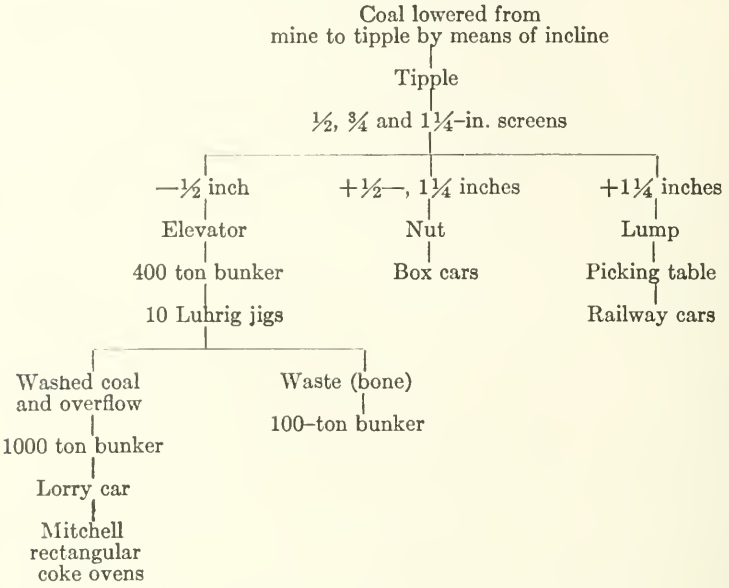
Blasting Methods.—The blasting is done with fuse, No. 6 detonators and Monobel powder, and is under the personal supervision of shotfirers.

Ventilation.—The mine is ventilated by a Jenckes fan, 10 ft. in diameter, which delivers 60,000 cu. ft. of air per minute.

In timbering, 6 lineal feet of props are used per ton of coal mined.

The mine has a capacity of 700 tons per day, but the average daily output is about 400 tons. There are 150 men employed underground and 30 above ground.

The coal is hauled by horses from the main entry to the head of the gravity plane ; thence, by gravity plane to the tipple and washery situated at the railway siding. The following diagram gives the flow sheet of the tipple and washery :



Three sizes are made at the tipple—lump, nut, and coal for washery. The lump coal is screened over a 1¼-in. screen, picked and loaded into railway cars. The nut coal is screened over ½-in. and ¾-in. screens and loaded into box cars. The coal which has passed through a ½-in. screen is elevated to a 400-ton bunker at the washery ; from the bunker the coal is fed to 10 Luhrig jigs, each having a capacity of 5 tons per hour.

There are installed at the tipple :

Four 150-h.p. return tubular boilers.
One 300-h.p. steam engine, connected to—
One 150-k.w. direct current generator.

There are installed at the mine :

Two 60-h.p. locomotive-type boilers.
One small air compressor ; and
A small hoist for hauling the empty cars to the mine from the tipple.

Coke Ovens.—The overs from the jig are stored in a 1,000-ton capacity bunker ; from it the coal is charged by lorry car into 101 Mitchell rectangular coke ovens. A coke oven charge is 6 tons and the coking period is 48 hours. Provision has been made in the construction of the ovens for electric leveller, pusher and conveyer so that the coke may be mechanically loaded into railway cars. The ovens were put in operation in 1912.

West Canadian Collieries

This company is operating mines at Blairmore, Bellevue, and Lille.

Blairmore Mine

This mine is situated at Blairmore, and is connected by a spur track about one-half mile in length, with the Crowsnest branch of the Canadian Pacific ry. near Blairmore station.

The thickness of the coal seam varies from 10 ft. to 12 ft. As the lower portion of the seam is dirty coal, averaging about 40 per cent ash, the upper 5 ft. to 6 ft. only is worked. The strike of the seam is N.—S. and the dip varies from 35° to 50° to the west. It is occasionally broken by faults and is not disturbed by rolls.

A small quantity of gas is evolved from the coal, but the return air-way does not show an appreciable amount. Wolf safety lamps are used in the mine, but the main gangway to No. 43 chute is lighted by electricity.

The entrance to the mine is by a 7 ft. x 9 ft. level tunnel driven on the strike of the seam. The maximum cover over any portion of the workings is 900 ft.

Method of Mining.—The same method of mining is used as in the Bellevue mine, excepting that the rooms are driven across the pitch, 12 ft. wide, the pillars are 38 ft. wide and the chutes 6 ft. wide. The rooms are timbered with full sets and lagging which keep up the cap rock. (See illustration p. 136 for method of working Bellevue mine.)

The pillars are removed down to the counter gangway. An extraction of from 80 to 90 per cent is obtained from the present workable coal.

The coal is hauled from the chutes to the bankhead by means of horses.

The roof is hard slate, which is traversed by slips and these blocks of slate often fall in the rooms. The floor is shaly coal.

Blasting Methods.—The blasting is done under the supervision of shotfirers, No. 7 detonators and Monobel powder being used. The tamping material used is clay, which is sent into the mine. 'Windy' shots are rare and the mine has never experienced any explosions.

Ventilation.—An 8 ft. x 5 ft. (wide) Sullivan all-steel fan is used for ventilating the mine, delivering 65,000 cu. ft. of air per minute, with a 4-inch water gauge.

In timbering, two lineal feet of props are used per ton of coal mined. The boiler plant consists of two 150-h.p. return tubular boilers. The power plant consists of a 300-h.p. steam engine belted to 75-k.w. and 100-k.w. generators, the electricity being used for lighting and power purposes.

The mine has an average output of 700 tons per day. The number of men employed underground is about 100; 45 are employed above ground. The coal is picked on a travelling belt and the total output is shipped as run-of-mine. Occasionally, a little slack under three-quarters of an inch is marketed. The mine has a track capacity for 20 thirty-ton loaded railway cars and 35 empty cars.

Bellevue Mine

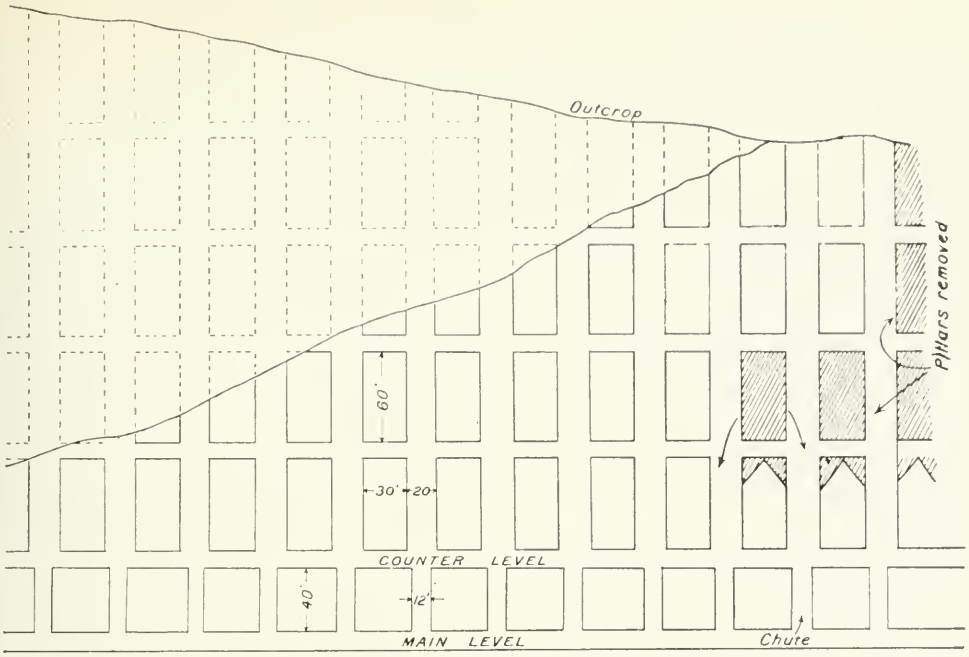
This mine is situated at Bellevue, on the Crowsnest branch of the Canadian Pacific ry. Six seams of coal have been prospected on the property.

The following table gives the thickness of the seams and the thickness of the strata between each seam :

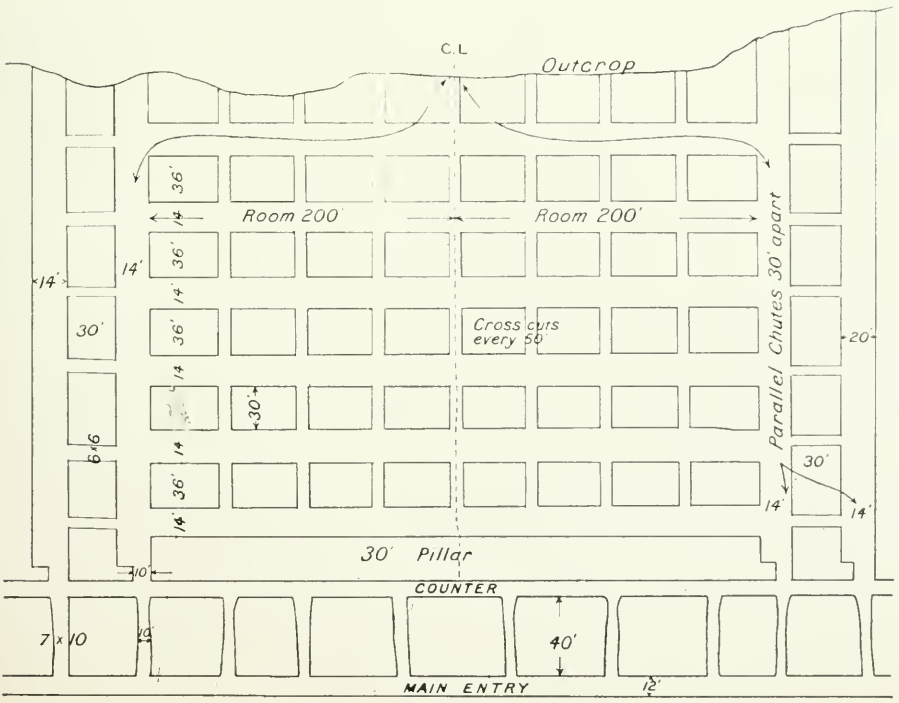
Thickness of intermediate strata	Seam	Thickness of Seams
	No. 1	12 ft. Being worked.
80 feet	No. 2	4 ft. to 12 ft.
100 feet	No. 3	2 ft. to 3 ft.
300 feet	No. 4	6 ft. Workable in places.
12–15 ft. apart.	No. 5	Several bands of rock with 2 to 3 feet of coal in between.
	No. 6	Several bands of rock with 2 to 3 feet of coal in between.

Of the foregoing, only No. 1 seam is now being worked. This seam varies in thickness from 12 to 14 ft. with a fairly constant average thickness of 12 ft. The strike is N. 12° W.; the dip varies from 35° to 45° W. It is not disturbed or broken by faults.

Method of Mining.—The entrance to the mine is by crosscut tunnel which intersects the coal measures at 300 ft. from the surface. The elevation of the entrance is about 4,000 ft. above sea-level. The vertical depth of the coal bed below the entrance is about 80 ft., and the maximum cover is about 600 ft. The system of mining used is chutes and pillars.



SKETCH SHOWING METHOD OF WORKING, DAVENPORT MINE



BELLEVUE MINE

SKETCH SHOWING ALL THE ROOMS DRIVEN BETWEEN TWO PAIRS OF CHUTES.

Pillars are removed by commencing at the point indicated by arrows.

Every 400 feet, parallel chutes 30 ft. apart, are driven from the main entry to the surface. (See sketch p. 136.) These chutes are opened up off the counter level with a width of 10 ft. and widened to 14 ft. a short distance above the counter level. The rooms are 200 ft. long and 14 ft. wide. The room pillars are 30 ft. wide and cross cuts are driven every 50 feet. A barrier pillar 36 ft. wide is left between the chutes to protect the counter entry. As soon as all the rooms have been driven between any two chutes, the pillars are removed from the outcrop down towards the entry. About 85 per cent of the coal is recovered. The roof is a hard sandstone, which often stands for a long period even after the pillars have been removed. The floor is smooth and is composed of hard sandstone.

Gas has been found in the mine and Wolf safety lamps are used. In an explosion on Dec. 9th, 1910, 31 men were killed.

Electric light, 220 volts, is used in the main entry as far as No. 26 chute.

Ventilation.—The mine is ventilated by means of a belt-driven Capell fan, 12 ft. diameter, delivering 80,000 cu. ft. of air per minute with a water-gauge of 2 inches.

Two lineal feet of props are used per ton of coal mined.

Four compressed-air locomotives are used for haulage on the main entry. The mine cars are steel with a capacity of 6,000 pounds. The track gauge is 3 feet.

Blasting Methods.—The blasting is done by battery under the personal supervision of a shotfirer.

The mine has an average output of about 1,200 tons per day; employs 200 men underground and 75 above ground. Nearly all the output is shipped as run-of-mine, picked on belt, and sold to the railway. Some slack coal is sold to cement works.

Mine Equipment.—The mine has a track capacity for 2,500 tons of coal.

The boiler plant consists of six 150-h.p. return tubular boilers. The power plant consists of one 15-k.w. electric generator for lighting purposes, driving fan, tipple, etc., and one high-pressure air compressor. The steel tipple, fitted with a Green dump, has a capacity of 1,500 tons per day.

Lille Mine

This mine is situated about seven miles from Frank, and is connected with the Crowsnest branch of the Canadian Pacific ry. by a branch line.

The following seams have been prospected on the property :

COAL SEAMS, LILLE MINE

Seam	Thickness	Thickness of intermediate strata	Remarks
No. 1	6–12 ft.	30 ft.	Present workings
No. 2	8–12 ft.	100 ft.	
No. 3		80–100 ft.	Considered valueless ; very much disturbed ; coal and shale.
No 4.			

Of the above-mentioned seams, only the upper one is worked at present.* This varies in thickness from 6 ft. to 12 ft. The strike is N. 10° E. and the dip about 40° W. The seams are not faulted, but rolls are frequently met with in the workings.

Method of Mining.—The system of working used is room-and-pillar. Double chutes from 150 ft. to 300 ft. apart are driven up the pitch from the main entry and the rooms are driven off these across the pitch. The room widths are 20 ft. and the room pillars 30 ft. wide. Crosscuts are driven every 50 ft. As soon as all the rooms have been driven between the chutes the pillars are removed. The percentage extraction, excluding dirty coal, is about 85 per cent. The entrance to the mine is by tunnel on No. 2 seam, and rock crosscut tunnel to No. 1 seam.

Compressed-air engine haulage is used on the main entries.

Gas has been found and Wolf safety lamps are used in the mine.

Blasting Methods.—Blasting is done under the personal supervision of shotfirers, Monobel powder, fuse and No. 6 detonators being used. The company have changed this method and all shots are fired by battery. The tamping material is clay, which is sent nto the mine. 'Windy' shots do not often occur, and the mine has never experienced any explosions. In timbering, 3 lineal feet of props are used per ton of coal mined. The main roof is sandstone with cap rock of about 4 ft. of shale ; the floor is shale and rather rough.

Ventilation.—The mine is ventilated by a belt-driven Murphy fan delivering 36,000 cu. ft. of air per minute, with a water gauge of 1½ in. There are two splits in the ventilation system.

The mine has a capacity of 700 tons per day, but the actual average is about 600 tons. There are 198 men employed underground and 38 above ground, not including those employed at the coke ovens.

Coal from the mine passes over a Phillips cross-over dump where it is screened to 1¾ inch. The over-size, after picking, is marketed ; the under-size is sent to the washery, which is situated about a mile higher up the valley.

* This mine is not now in operation (Oct. 1913).

Washery.—The washery has a capacity of 30 tons per hour and is operated by 6 return tubular boilers aggregating 480 h p. A belt passing below the cars conveys the coal to an elevator, which delivers to a ½-in. trommel screen. The oversize is sent to the boilers, while the undersize is sent to ten Luhrig jigs. The refuse, from the jigs, constituting 20 per cent of the original and assaying from 35 per cent to about 50 per cent ash, is thrown on the dump. The washed coal is elevated to storage bins having a capacity of 500 tons. From the storage bins, it is distributed to the coke ovens by lorry cars.

Coke Ovens.—The coke ovens—50 in number—are of the Bernard pattern, Belgian type, and have a capacity of 150 tons per day. The coking period is 48 hours. The ovens, which are discharged by ram, have a recovery of 72 per cent.

The power plant at the mine consists of 4 return tubular boilers aggregating 500 h.p. They provide power for the operation of the high-pressure air compressors, which compress air to 1,000 lbs. to the square inch for locomotive haulage.

Hillcrest Collieries

This mine is situated on a hill, a mile and a half from Hillcrest station on the Crowsnest branch of the Canadian Pacific ry. The mine tipple is on the valley level, and is connected with the railway by means of a mine spur seven-eighths of a mile in length. The coal is brought from the mine to the tipple by means of a steel rope and disc conveyer.

The following seams have been prospected on the property :

COAL SEAMS, HILLCREST COLLIERIES

Thickness of intermediate strata	Seam	Thickness	Remarks
No. 1 to No. 2—100 ft.	No. 1	14 ft.	Being worked
	No. 2	6–8 ft.	Dirty and unworkable
No. 2 to No. 3—300 ft.	No. 3	10–12 ft.	Dirty and unworkable.

At present the upper seam only is being worked. The strike of the coal is about northeast and the dip 28° to the west. The seams are badly broken by faults, and the coal is cut off by a fault at the face of the main entry, 4,000 ft. from the entrance.

Method of Mining.—The entrance to the mine is by tunnel driven on the outcrop, but, as the coal has been mined to the surface above the main entry, the company have driven a rock cross-cut tunnel and the coal is now being mined to the dip. The system of mining is pillar-and-stall. (See plan facing page 140.) Chutes are driven

up the pitch to the surface. The chutes are 14 ft. wide and vary in length from 400 ft. to 800 ft. The room pillars are 50 ft. wide and crosscuts are driven in steps on each side of the chute every 50 ft. An extraction of 85 per cent is obtained. The pillars are removed by slicing on each side of the chute. The roof is sandstone with a 6-inch cap rock.

Gas has been found in the mine and Wolf safety lamps are used. Electric light, 250 volts, is used in the main road for a distance of 2,000 ft. from the entrance.

Blasting Methods.—The blasting is done under the supervision of shotfirers. Monobel powder, No. 6 detonators and fuse are used for blasting down the coal. Forty per cent and sixty per cent dynamite are used in rock work. The tamping material used for stemming the holes is clay, which has been sent into the mine. The mine is not subject to 'windy' shots nor has it experienced any explosions.

The haulage system on the main entry is by horse, while 12 in. x 15 in. locomotives haul the coal from the entrance to the tipple.

In timbering, 3 lineal feet of props are used per ton of coal mined. The mine has a capacity of 2,000 tons per day, but the actual average is about 800 tons. There are 250 men employed underground and 70 above ground.

The coal is picked on the tipple conveyer and 90 per cent of the output is shipped as run-of-mine.

The following machinery has been installed near the entrance of the new rock cross-cut :

Six 150-h.p. return tubular boilers ;

A three stage high-pressure air compressor for locomotive haulage ;

105-k.w. generator, for lighting and power purposes ;

250-h.p. hoist for hoisting out of the new 1,800-ft. slope.

Maple Leaf Mining Company

This mine is situated on the north side of the valley, a mile and a half east of Hillcrest station. It is connected with the Crowsnest branch of the Canadian Pacific ry. by a three-feet gauge railway. A gasoline engine hauls the mine cars from the mine entrance to the tipple at the railway siding.

Three seams have been prospected on the property :

No. 1 seam, 10 ft. to 12 ft. thick.
No. 2 seam, 12 ft. to 14 ft. thick.
No. 3 seam, (impure coal) 8 ft. thick.

One hundred and eighty-five feet of strata separate No. 1 seam from No. 2, and 200 feet of strata separate No. 2 from No. 3 seam.

MINE PLAN, HILLCREST COLLIERY

The strike is approximately north-and-south, and the dip 45° to the west. The seams are not badly faulted but "pinch outs" are frequently met with in the workings.

Method of Mining.—The entrance to the mine is by crosscut tunnel to No. 1 seam. The system of mining is pillar-and-stall. Chutes 12 ft. wide, varying in length from 100 ft. to 400 ft. are driven up the pitch from the main entry to the surface. The room pillars are 33 ft. wide. The coal has been mined to the surface for a distance of 1,500 ft. along the main entry. The pillars are removed by slicing the top portion of the pillar parallel to its diagonal. The total recovery is about 85 per cent.

The roof is hard sandstone and does not fall readily in the rooms even after the pillars have been removed. Gas has been found in the mine and Wolf safety lamps are used exclusively.

Blasting Methods.—The blasting is done by fuse, No. 6 detonators and Monobel powder under the personal supervision of shotfirers.

In timbering, 6 lineal feet of props are used per ton of coal mined.

Ventilation.—The mine is ventilated by means of a Sirocco fan delivering 50,000 cu. ft. of air per minute.

The mine has a capacity of 600 tons per day but the actual average output is 400 tons. There are 40 men employed underground and 15 above ground. About 75 per cent of the output is shipped as run-of-mine, but the screens at the tipple are so arranged that lump and slack coal (under 1¼ inches) can be produced.

Mine Equipment.—The tipple has storage bin capacity for 300 tons, and the railway siding has a capacity for 15 loaded cars.

The boiler and power plant consists of :

One 150-h.p. return tubular boiler ;
One 60-h.p. locomotive-type boiler ;
The high-pressure half of a 14 in. x 22 in. air compressor, which furnished power for mine pumping.
One 75-k.w. alternating current generator, which is used for power and lighting purposes.

Davenport Coal Company

The mine is situated on a railway spur one-quarter mile from Burmis on the Crowsnest branch of the Canadian Pacific ry. The following seams have been prospected on the property :

COAL SEAMS, DAVENPORT COAL CO.

Seam	Thickness	Distance to next seam*
No. 1	3 ft. coal	96 ft. to No. 2
2	4 ft. coal	10 ft. to No. 3
3	4 ft. coal	50 ft. to No. 4
4	4 ft. coal and 5 ft. of dirt	50 ft. to No. 5
5	8 ft. coal	

No. 2 seam only, is being worked at present. The strike of the seam is approximately north-and-south ; the average dip is 45° W.

Method of Mining.—The entrance to the mine is by tunnel on No. 5 seam and rock cross-cut to No. 2 seam. The system of mining is room (chute)-and-pillar. (See sketch p. 136.) The chutes are driven from the main level to counter level with a width of 12 ft.; above the counter level the chutes are widened out to 20 ft. and driven up the pitch to the surface. The room-pillar width is 30 ft.; 10 ft. by 4 ft. crosscuts are driven every 60 ft. The pillars are removed by starting at the counter level and working up the pitch with a longwall face. The roof is sandy shale and stands even after the pillars have been removed. The floor is sandy shale.

Gas has been found in the mine and Wolf safety lamps are used exclusively.

Blasting Methods.—The blasting is done under the supervision of shotfirers, Monobel powder, No. 6 detonators and fuse being used. The holes are stemmed with clay, which is sent into the mine for that purpose.

Ventilation.—The mine is ventilated by means of a Sirocco fan delivering 50,000 cu. ft. of air per minute, with a water gauge of 3 inches.

In timbering, one and one-half lineal feet of props are used per ton of coal mined.

The mine has a capacity of 500 tons per day but the average daily output is about 370 tons. All the output is shipped as run-of-mine. There are 46 men employed underground and 14 above ground.

*Measured along the dip.

COAL MINES OF BRITISH COLUMBIA

Mining Methods in the Crowsnest District

GENERALLY speaking, the coal seams in the Crowsnest district in Alberta and British Columbia, have steep dips, and outcrop in a hilly or mountainous region. As the railways which afford transportation facilities follow the valleys, the usual practice is to develop the mines by tunnels driven from the level of the valley, the coal being mined to the rise of the tunnel.

These conditions, where the cover is not very great, are favourable to economic mining, as haulage, pumping and ventilation problems are not difficult ; but, as soon as the coal to the rise has been mined and a second lift undertaken, the conditions will be more unfavourable. The steep dips quickly increase the cover over the workings, and timbering, ventilation, pumping and haulage problems will become serious factors. Some of the mines are now mining a second lift, and, eventually, all will be working highly pitching seams under great cover, in which there are also a number of seams present in the measures. The mines are, as a rule, gaseous, and, on account of their dip, dry in places ; consequently they present, and will present, other adverse conditions.

Hosmer Mine

The mine is situated at Hosmer, B.C., a town on the Crowsnest branch of the Canadian Pacific railway, eight miles north of Fernie. The seams, with a total thickness of 116 ft. of coal, have been prospected by a crosscut tunnel about 4,930 ft. in length, driven from the Fernie shales, below the coal measures, to the hard conglomerate which overlies them. Five seams, aggregating 48 ft. of coal, are considered workable. They are as follows :

No. 2 seam	10 ft.
No. 6 "	7 "
No. 8 "	6 "
No. 9 "	5 "
No. 10 "	20 "

The dip of the seams varies from 30° to 65° to the east. They are frequently broken by faults and "pinch outs" often occur. Seams No. 2 and No. 6 are developed more extensively than the others, and produce most of the present output—about 700 tons per day.

Gas has been found in the mines and Wolf safety lamps are used.

METHOD OF MINING.—The system of mining is room-and-pillar. The working face is sheared by machines and then picked down. No

blasting is done in the mine. The method of attack is as follows : Gangways are driven off the main tunnel in coal ; double chutes, 40 ft. apart, are driven up the pitch from the main gangway every 400 feet to the next level situated 500 ft. above the gangway. The rooms are opened off the chutes and driven across the pitch to meet the corresponding rooms from the next chute. The rooms are 12 ft. wide and the room pillars 40 ft. wide. No room pillars have yet been drawn. The maximum cover over any portion of the workings is 1,200 ft.

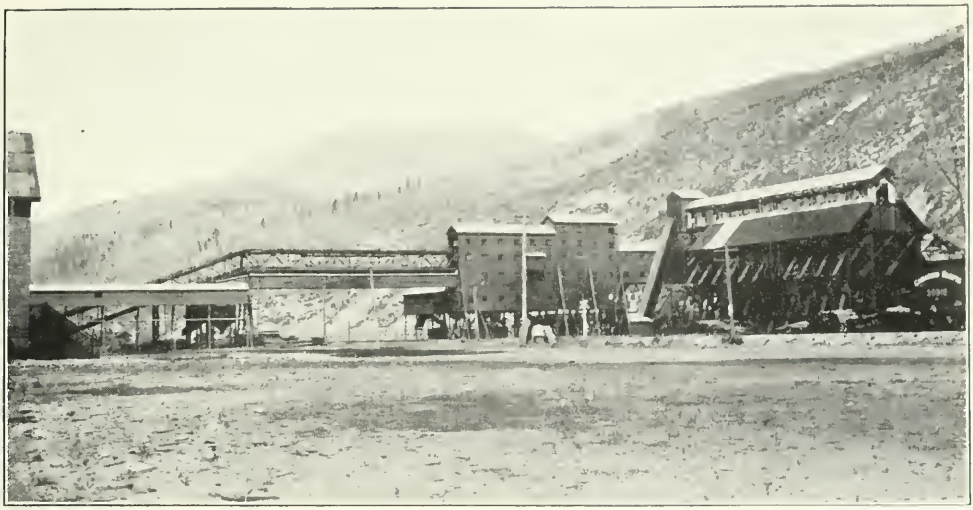
The coal is trammed from the face of the rooms and dumped into chutes. It is loaded into 2-ton mine cars from chutes on the main gangway and hauled out by compressed-air locomotives.

In timbering, 3 lineal feet of props are used per ton of coal mined.

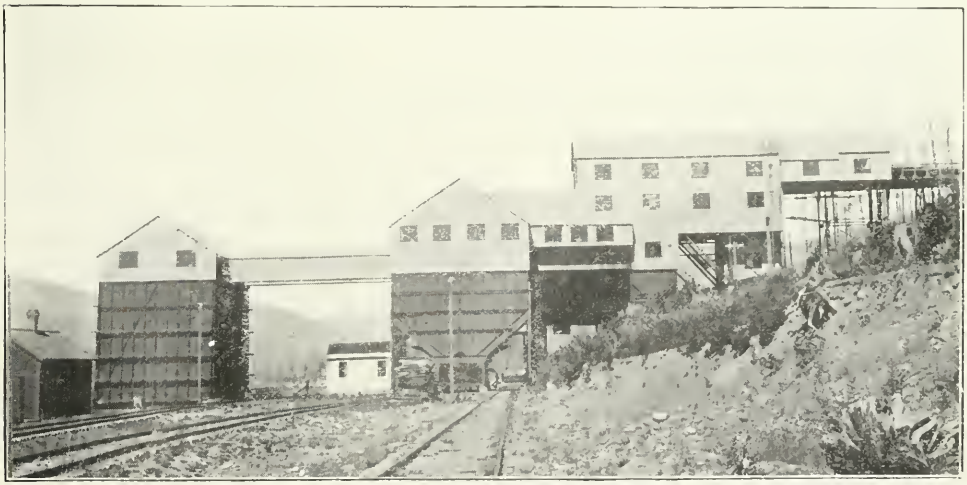
The coal is lowered in "trips" of 20 cars from the mouth of the tunnel (elev., 4,011 ft.) to the tipple level (elev., 3,531 ft.) by means of a steam-actuated double-track incline 3,550 ft. long. From the foot of the incline to the tipple, it is hauled by compressed-air locomotives, and there discharged on a Phillips cross-over dump into a steel hopper, from which it is fed by a reciprocating feeder to two shaking screens placed one above the other, size 16 ft. by 6 ft., with 1-in. and ½-in. punched holes. The over-size from the 1-in. screen passes to two steel picking belts 4 ft. 9 in. wide by 30 ft. long, and is discharged into storage bins of 2,400 tons capacity. Forty per cent of the output of the mine passes over the 1-in. screen.

The slack coal is conveyed by scraper conveyers to coke-oven bins having a capacity of 3,000 tons. The over-size from the ½-in. screen passes to a Robinson washer ; the washed coal passes to a ¼-in. trommel and the over-size is discharged into either the nut-coal or coke-oven bunker. The under-size from the trommel passes to a settling tank ; the overflow from the settling tank is pumped to a second settling tank and the water is returned to the Robinson washer. The fine coal from the settling tanks is conveyed to the coke-oven bins. The washery has a capacity of 500 tons per day. Compressed-air locomotives haul the slack coal from the slack bin in 7-ton lorry cars, to the coke ovens. The tipple is built entirely of steel and is designed to operate in two units, each of which may be worked independently of the other. There are 240 coke ovens of the beehive type, each 12 ft. in diameter and 7 ft. high and with a capacity of 400 tons of coke per day.

From the foregoing description of the washery, it can be seen that nothing is wasted. The lump and nut coal is marketed, and the slack coal and sludge are converted into coke.



Steel Tipple, Crowsnest Pass Coal Co., Michel, B.C.



Steel Tipple, Hosmer Mines, Ltd., Hosmer, B.C.

Surface Plant.—The following description of the surface plant is taken from a paper, by H. H. Yuill, published in the *Transactions of the Canadian Mining Institute, Vol. XIII., 1910.*

All the permanent buildings of the surface plant except the fan engine house, which is built of brick, are of reinforced concrete construction, and the tunnel entries are of concrete, as is also the connection of the smaller tunnel with the fan. A 9 ft. x 20 ft. Walker fan, speed 150 revolutions per minute, provides ventilation for the mine. It is driven with a rope drive by a pair of 16-in.x 30-in. engines, originally the steam end of the Rand Compressor, which runs at 100 revolutions per minute. The fan is ordinarily run as an exhaust, but it can be changed to a blow fan, at short notice, and is capable of supplying 300,000 cu. ft. of free air per minute. The steam for the fan engine is supplied by 3 'Economic' boilers of 80 h.p. each. The other buildings at the tunnel mouth are a concrete lamp house, a locomotive house for the compressed air locomotive, and a well equipped wash-house,—with lockers—for the miners. The main power-houses and shops are at the foot of the incline.

The boiler-house is a building of reinforced concrete provided with steel roof trusses covered with corrugated iron. Three hundred and ninety one yds. of concrete were used in the construction of this building; it is 70 ft. x 50 ft. and contains six 250-horse-power Babcock & Wilcox water tube boilers, equipped with chain grates and mechanical appliances for handling the coal and ashes. The building is designed to hold eight of these boilers, the other two will be installed when needed. The floor of the building is of concrete.

The power-house is of the same construction and contains :

(*a*) Two Norwalk compressors, steam 26 in. x 30 in., two-stage to 100 lbs. sq. in., each having a capacity of 1659 cu. ft. of free air per minute. The air from these compressors is used for the rock drills in tunnel, shearing machines, timber hoists in the mine, and various other purposes around the plant.

(*b*) Two Norwalk compressors, steam 26 in. x 30 in., 3 stage, 50 lbs., 250 lbs., 900 lbs. per sq. in., respectively ; each having a capacity of 840 cu. ft. free air per minute. The air from these compressors is used for charging the Porter air locomotives, of which there are five, two 7 in. x 14 in. at the mine, one 6 in. x 10 in. and two 7 in. x 12 in. below the incline ; main reservoir, maximum, 900 lbs. The auxiliary reservoir runs 140 lbs. sq. in.

In the power-house are two 75-k.w. General Electric a.c., generators, volts, full load 2300-amperes 18.85; speed, 900, which

are driven by two Robb-Armstrong engines 14 in. x 14 in. These provide power for the lighting of the town and the mine plant.

All the engines have adjustable cut-off valves ; the purpose is to supply steam at 120 lbs. sq. in., cut off at ¼ stroke and use the steam expansively.

The steam from any or all of the engines can be turned either into the atmosphere or through a 1500-horse-power Hoppe's exhaust steam heater 5 ft. 8 in. diameter by 9 ft. long, which heats the boiler feed water to 204° F. This building is 53 ft. x 87 ft.—20 ft. wall. Six hundred and thirty yards of concrete were used in the walls and foundations. The walls are heavily reinforced, 1–2–4 mixture of concrete was used for the curtain walls, while 1–3–6 mixture was used for foundations and the other walls.

The haulage engines are in a building conveniently situated near the bottom of the incline. These engines which were made by the Vulcan Iron Works, Wilkesbarre, Penna., are a pair of first-motion engines 28 in. x 48 in. with two 8-ft. drums having 4-ft. faces. The clutches, brakes and reversing gear are all controlled by steam working through cataract cylinders.

The power for the shaking screens and picking belts in the tipple is derived from an Atlas Duplex Engine, 12 in. x 16 in. The Slack rock conveyer is driven by a 25-h.-p. electric motor.

The power for the Chicago concrete mixer, and the Austin gyratory crusher which breaks to 1¼ in. is supplied by an 8½in. x 10-in. portable engine and boiler, placed on trucks.

The various shops are well equipped, as follows :

Blacksmith Shop.—One No. 2 double punch and shear, 25 in. throat, belt driven ; 1 David Bell standard guide frame steam hammer, 6 in. x 18 in. cylinder, weight 7200 lbs. ; 1 plate bending roll ; one 36-in. forge; one 48-in. forge ; one 60-in. forge ; and a Stur evant-Sheldon blower.

Machine Shop.—One pipe-cutting and threading machine; 1 Norton pedestal grinding machine; one 40 in. grindstone; 1 McCabe double spindle lathe, 26 in.—48 in. swing, 24 ft. between centres, 30-ft. bed ; one 16 in. x 10 in. screw cutting lathe, ½ in.–18 in. swing, 6-ft. centres ; one 30 in. x 30 in. heavy pattern planer ; one 3-ft. combination radial drill with worm swivelling table ; one 14-in. sensitive drill, drill chuck up to ½ in.

Carpenter Shop.—One Universal rip and cross-cut aw; 1 band saw; 1 perfection planer and jointer ; 1 single-spindle vertical boring machine ; one 24-in. swing wood lathe with countershaft.

With this equipment all the repairing necessary can be done on the premises, while the shops are also capable of making mine-cars, etc.

Corbin Coal and Coke Company

This mine is situated at Corbin on McGillivray creek. A branch line, 12 miles in length, connects it with McGillivray, on the Crowsnest branch of the Canadian Pacific ry.

The mine* is opened up by a tunnel, 14 ft. by 8½ ft. in the clear, and 2,200 ft. in length. The entrance to the tunnel is approximately on the valley level, sufficient elevation being allowed above the railway tracks for the tipple, so that the coal can be hauled out of the tunnel, picked, screened and loaded directly into railway cars.

The coal seam varies in thickness to a maximum of 150 ft., but, whether this figure represents its true thickness or not, it is impossible to say, as the geology has not been thoroughly worked out. The strike is about S. 18° W. and the dip 70°-75°. The seam outcrops along the crest of the hill about 1,600 ft. above the main tunnel.

Gas has been found in the mine and Wolf safety lamps are used exclusively.

Method of Mining.—The system of mining used is pillar-and-stall. There are three main tunnels above the main entry, "B", "D", and "E". Between "B" and "D" there are five levels about 40 ft. apart, and there are three levels about the same distance apart above "E" tunnel. The tunnels and levels are connected by 6 ft. by 10 ft. raises. In the thicker portions of the seam, rooms are opened off the levels and the coal is loaded in cars, trammed on the level and dumped into the raise or chute. These chutes continue to the main tunnel "A", from which the coal is loaded into cars and hauled to the tipple by compressed-air locomotives.

The raises are driven 40 ft. apart. The rooms are 12½ ft. wide and the room pillars 40 ft. The rooms vary in length up to 150 ft. No pillars have been removed underground, but those on the outcrop are at present (1912) being removed by open-cut work. The coal is dumped into a long chute, which extends to the main tunnel below.

Blasting Methods.—The blasting is done with Monobel powder, fuse and Bickford patent fuse-igniter.

Ventilation.—The mine is ventilated by means of a small fan, 4 ft. x 12 ft., direct connected to an 8 in. x 12 in. steam engine, which circulates 54,000 cu. ft. of air per minute. There are four splits in the ventilation system.

In timbering, two lineal feet of props are used per ton of coal mined.

The mine has a capacity of 1,000 tons per day, but the average output is about 400 tons. All the output is shipped as run-of-mine, but, in order to facilitate picking the lump coal on the picking table,

* This mine is now on fire and is not in operation (Oct., 1913).

the coal is first screened over a bar screen with 2-in. spaces. The lump coal and slack coal are united in the bins, which have a capacity of 1,000 tons.

The mine has a track capacity for 20 thirty-ton loaded railway cars, and the same number of empty railway cars.

There are about 175 men employed underground and 45 above ground.

Mine Equipment.—The boiler plant consists of two 50-h.p. locomotive-type boilers and two 120-h.p. return tubular boilers.

The power plant consists of one 80-h.p. steam engine and dynamo and one cross-compound, four stage, high-pressure air compressor, capacity 776 cubic feet of free air per minute, compressing air to 1,000 lbs. for locomotive haulage.

The company has also stripped, by means of hydraulic monitors, a large coal seam on the hill a short distance to the west of the present workings. A railway has been constructed to this mine, and the coal is being mined by steam shovel.

Crowsnest Pass Coal Company

This company operates the following collieries in East Kootenay district :

Coal Creek Collieries
Michel Collieries

Coal Creek Collieries

The mines are situated in Coal Creek valley, five miles east of Fernie, and at an altitude of about 3,600 ft. above sea-level. A branch railway, five miles in length, with an average grade of two per cent, connects the mines with the Canadian Pacific ry. at Fernie.

The general line of strike of the coal measures is approximately north-and-south, with an easterly dip varying from 10° to 15°. As the valley of Coal creek cuts across the measures, the surface outcrops of several of the seams are exposed at a considerable height above the tipple level.

The following mines are in operation:

North side of valley—
- No. 5, North
- No. 1, North
- No. 9
- Old No. 1

South side of valley—
- No. 1, East
- No 2
- No. 3
- No. 1, South

These mines are opened up on three different seams, No. 1 North, Old No. 1, No. 1 South and No. 1 East being on the same seam. No. 2 and No. 3 mines are working on the same seam as No. 9 mine seam. No. 5 seam is about 10 ft. thick and is separated from No. 9 seam by about 500 ft. of strata. No. 9 seam varies in thickness from 4 ft. to 7 ft. and is separated from No. 1 seam by strata varying in thickness up to 120 ft. No. 1 seam varies in thickness from 25 ft. to 30 ft. These seams have been correlated with the Morrissey section measured by Mr. McEvoy, and No. 1 seam probably corresponds with No. 63 of that section.*

The north and south side coal are brought to the same tipple. It is of steel construction, 840 feet in length, and extends across the valley of Coal creek. Faults are infrequently met with in mining the seams, but, where disturbances do occur, they are more in the form of small overlap folds than faults.

Gas has been found in the mines and Wolf safety lamps are used exclusively.

Blasting Methods.—Very little blasting is done in the coal and, where explosives are used, the shooting is done by battery and with the permitted explosives, Saxonite and Monobel. The tamping material used in stemming the holes is blue clay, which is sent into the mine. From the foregoing it can be seen that precautions are taken to prevent the ignition of gas by means of miners' lamps or during blasting operations.

Method of Mining.—The system of mining used is pillar-and-stall in the thick seams and longwall in the thin seams. Old No. 1, No. 1 South and No. 5 are worked by pillar-and-stall; No. 9, No. 2 and No. 3 are worked by longwall.

In the pillar-and-stall workings, it has been the custom in the past to drive the rooms 12 ft. to 16 ft. wide and 300 ft. in length, and to leave room pillars 40 ft. to 50 ft. in width. It has been found that, owing to the great pressure exerted by the heavy weight of cover (2,000 ft.–2,500 ft.), that 40-ft. pillars will cause a "creep," thus making it impossible to draw the pillars.

The following is a report on "bumps" in the Crowsnest coal-field by W. F. Robertson, Provincial Mineralogist.†

"Bumps"—What They Are

The term 'bump' is somewhat descriptive of the sensation produced by their occurrence a certain distance away—a sudden jarring

*Annual Report (New Series), Vol. XIII., 1900, Geological Survey of Canada.
†Annual Report of Minister of Mines, B.C., 1908.

of the mine, produced by the sudden giving away or cracking of the strata above or below the coal seam.

Cause, in No. 2 Mine.

These 'bumps' are caused by a combination of conditions, which may be summarized as follows :

The great pressure from overlying measures, upon the rigid and inflexible roof of the coal seam, the area of pillars of coal left to support which, being insufficient, causes undue pressure, which pressure being transmitted to the underlying 'pavement,' a comparatively soft, carbonaceous shale, causes this shale to burst upwards in the openings made by the roadways, with the sudden liberation of gas contained in the shale. The shock so caused frequently jars down portions of the roof and slivers off portions of pillars of coal, with a probable further liberation of gas.

Location of Mine.—No. 2 mine is the most extensively developed mine on Coal creek and one of the first opened up, and it was here that the great explosion occurred in 1902, whereby many lives were lost. The general range of mountains in which the coal occurs runs north and south, on the east side of the Elk river, the coal outcropping on the face of these hills, high up above the valley of the Elk river, the seams dipping to the eastward into the mountains. Coal creek, flowing from the east into Elk river, has cut a deep V-shaped valley into and at right angles to the mountain range. The development of the coal fields took place where the coal seams in their dip met the valley of Coal creek, permitting of adit levels or tunnels being driven north and south in from the creek valley on the coal seams, in the direction of their strike. The workings, when they started, had little overlying covering to cause pressure on the coal roof, but, as the work progressed into the hill, this cover rapidly increased, until, in No. 2 mine, the covering rocks are now from 2,000 to 2,500 feet thick, representing a pressure on the roof seldom equalled in the history of coal mining.

To add to the destructive effect of this pressure, the valley of Coal creek cutting across the measures leaves them supported at one end only, so to speak, like a beam supported at only one end; whereas, in most of the deep mines elsewhere, the coal is reached by a shaft and the measures have support from both sides—like a beam supported at both ends.

The result of the support of the measures being on one side only, is that the extraction of coal, starting from the creek or unsupported side of the measures, causes the measures to tend to slide towards that side, inducing a 'creep' and tendency to overthrow the pillars of

coal left for support of the roof, thus greatly increasing the destructive effect of the great roof pressure.

'Creep' is less dangerous with large pillars than with small ones, but, unfortunately, the pillars left are unusually small.

Description of Coal Measures.—The overlying measures consist of very hard sandstone, conglomerates and argillites, so tough and strong that they do not 'cave' and fill up the space where pillars are drawn over smaller areas. These measures are rigid and inflexible and press down as one solid mass upon the remaining pillars.

Immediately overlying the coal seam there is, varying from one to three feet in thickness, a very hard shale—a false roof—which parts readily from the main roof above, and, while it is strong enough to stand in most instances with little or no timber, under sudden concussion, or in course of time, it is liable to fall in the roadways and openings and has been the cause of a number of serious minor accidents.

The coal seam varies in thickness, say from six to twelve feet; the coal is strong and firm, as is shown by the pillars remaining intact, save where such pillars are small and have stood for considerable time.

The 'pavement' or strata underlying the coal seam is a shale much softer and more friable than the overlying strata, containing much carbonaceous matter, and presumably carrying and harbouring considerable gas.

Extent of Workings. *Main Entry.*—The workings of No. 2 mine extend into the mountain for about 4,000 feet in a straight line from the tunnel mouth, and have an average width at right angles to this line of about 3,000 feet ; the workings therefore extend over an area of about 275 acres.

The coal seam is not in a true plane—that is, the dip varies somewhat—and while some attempt has been made to keep the main entries straight, or nearly so, this has only been accomplished at the expense of varying grades or of taking down roof and taking up pavement. This could scarcely be demanded in the subordinate levels and roadways, and these have more or less closely followed contour levels or grades. Consequently, these subordinate drivages are very crooked, causing the pillars left to be rather irregular in shape and size.

While there was some excuse for these very irregular workings, they were admittedly not in accord with the best coal mining practice, which fact the company evidently recognized, as at about 2,800 feet in on the Main entry, at No. 2 West level, a change of plan was adopted and subsequently levels were driven straight and the

workings therefrom set off with regularity and according to plan, leaving pillars larger than formerly and laid out with considerable regularity. This more regular work continued to the No. 5 West level and most of the pillars between No. 2 and No. 5 were thus able to be and were extracted—practically the only part of the mine where this has been done except in an adjoining area, to the east of the High Line entry and worked from that entry.

Inside of No. 5 West level the workings have been extended for some 500 to 600 feet, and some 'longwall' work was carried on for a time, but afterwards abandoned for pillar-and-bord workings, which again assumed a very irregular form with little regard to any defined shape of pillar, although the pillars left were larger than formerly.

High Line Entry.—The High Line entry is a practically level entry branching off the main entry, some 100 yards from the tunnel mouth, bearing to the westward and running on a contour line around the western edge of a local sag or basin in the coal seam. For about 3,000 feet in on this entry, viz., as far as No. 1 East level, all the workings off this entry are exclusively to the right (west) side; for the remaining 2,000 feet the entry has been driven, the workings continue on the west, but levels have been run to the east, and these east workings join the workings to the west of the Main entry. To the west of the High Line entry the coal rises, eventually outcropping in a cross gully which flows into Coal creek. In consequence of this rise, and the configuration of the hill, the workings to the west of the High Line have a comparatively light and decreasing overburden, and no great difficulties have been met with in this section due to weight of overburden. The workings off to the east of the High Line, for the purposes of this report, might be considered as part of the workings off the Main entry, of which they really form a part, although the coal therefrom came out by the High Line entry.

No. 3 Mine.—To the east of the Main entry the workings are to the dip, and are operated through two slopes, Nos. 1 and 2. No. 1 slope goes down to the dip from the surface, just outside of the Main entry, and was formerly considered a separate mine—No. 3 mine. The No. 1 slope workings have been conducted with greater regularity as to plan, and the pillars are more regular and larger, while at the same time they underlie the valley of Coal creek and have not as yet worked under the mountain to any extent, so, consequently, have not as yet met with excessive pressure from over-burden. These workings have not been troubled by 'bumps' or similar manifestations. No. 2 slope, or 'Beaver's Deeps,' branches off the Main entry (at some 1,700 feet in) to the east, and towards the dip,

for some 1,300 feet. From this slope workings have been pushed to the south for about 1,000 feet at the upper part of the slope and about 600 feet at the bo tom of the slope. In the upper workings the pillars are small and irregular, but have as yet given no serious indication of weakness. In the lower of these workings the pillars are larger. All these workings are gett'ng under the mountain and are subject to heavy pressure, but have not as yet shown dangerous symptoms.

Pressure on Pillars.—The pressure on the coal roof induced by an overburden of 2,000 feet in thickness would be about 160 tons per square foot, over the whole roof surface, and when pillars alone are left to support it, the weight is concentrated on to the area of these pillars. The pillars left standing represent, approximately, only 50 per cent of original coal area, and, consequently, the pillars have to sustain about double the roof pressure, or about 320 tons per square foot. This they appear to have so far been able to do, but, as pillars deteriorate from exposure and other causes, they are gradually approaching the limit of endurance.

'Bumps'—Location of Area Affected

There have been from eight to ten important 'bumps' in No. 2 mine, and these seem to be increasing in violence as time goes on. Several years ago slight 'bumps' were reported, but they were unimportant in effect, and it was not until June, 1906, that they were noted as dangerous. In January, 1907, the first 'bump' causing loss of life occurred; since then there have been three others, the last on July 31st, 1908, when 24 men were cut off and all would have been suffocated had it not been for a supply of fresh air supplied by a break in the compressed-air pipes, enabling 20 men to be saved. The report of this last 'bump' shows a great accumulation of gas to have been liberated, with a breaking down of return air overcasts and a complete blocking up of the Main entry for some 600 feet.

The situation of the eight more serious 'bumps' are marked on the plan (not reproduced) by a red ink cross(x) and are lettered in order of sequence. A reference to this plan will show that the area of disturbance in which all these 'bumps' have occurred is between the Main entry and the High Line entry and immediately surrounding and including the area from which the pillars have been extracted, an area of about 1,500 by 1,000 feet, and this area stretches across from one entry to the other. These facts would indicate that the sagging of the roof over the area from which the pillars had been extracted caused an undue pressure on the immediately surrounding pillars, which, transmitted to the pavement, apparently caused it to burst upwards, with the liberation of gas and accompanying shock. There was apparently

no serious caving of overlying measures, that might fill up the space and relieve the pressure. The area of pillar extraction—some 30 to 35 acres—is situated in the centre of the mine workings and under an overburden of about 2,000 feet. In the present case the disturbances have, so far at least, been localised—whether they will spread to the rest of the workings, time only will show. I think there will be no sudden outburst, provided no further attempts are made to extract pillars, from a central area which has stood for some time. If the extraction of pillars had been commenced within a reasonable time and from the outcrop, the roof might probably have subsided behind such workings quietly and no serious disturbances have taken place.

Conclusions Arrived At

The mines of this company have admittedly been opened up and carried on with little regard to any defined regularity of plan, and with more regard to the then present than to the future and the development of what must become very extensive mines. The imperative demand for coal during the earlier history of the mines caused the company to try to meet that demand from an insufficient mine development. The result was that the future of the mine was neglected, and it has now come to a pass where strenuous measures have to be adopted by the company to overcome the difficulties brought about by what seemed then to be expediency and to lay the foundation for extensive workings. The pillars left are so small and irregular, particularly in the earlier workings, and have been left standing so long, that it is a question if they can be now extracted with either safety or profit. While the presence of these pillars does not constitute a direct menace, the absence of sufficient barrier pillars to protect the roadway and airways renders it undesirable that extended workings be continued through them.

The 'bumps' have occurred only in the immediate vicinity of an area where the pillars have been extracted, and it is highly probable that they will be confined to such locality, so that no extended danger is expected outside of this vicinity, provided no further extraction of pillar is undertaken in the old workings where the overburden is excessive. The zone of danger from 'bumps' extends completely across the mine from Main entry to High Line entry, inside No. 1 West level, Main, and No. 1 East level, High line.

Regulations Recommended

In view of the foregoing, Mr. Robertson recommended:

"1st. That the company be prohibited from continuing any of the present workings of No. 2 mine, lying between the Main

entry and the High Line entry inside of No. 1 West level, Main entry, and No. 1 East level, High Line, or of extracting pillars within this area of this mine. Such prohibition to include the Main entry and parallels inside of No. 1 West level.

"2nd. That such proscribed area may be enlarged, should it be found in course of time that serious 'bumping' or other disturbances have taken place beyond the present limits.

"3rd. That future workings into the virgin coal field, lying inside of present workings of No. 2 mine, be not permitted to be made through the proscribed section of No. 2 mine.

"4th. That a solid barrier pillar, at least 300 feet thick, be maintained between any new workings in virgin field mentioned and the proscribed area.

"5th. That, as far as possible the proscribed area be shut off from the remainder of No. 2 mine by substantial toppings and the return air from ventilation thereof be conveyed to main return airway by separate air return.

"I might say that I believe the present general manager, Mr. J. D. Hurd to be in accord with the above proposals—in fact, he has already anticipated them and his new plans have been so made. The only necessity for the restrictions being legally placed would be to guard against a change of policy on the part of the company.

Plans for Future Workings Proposed by Present Management

"The plan proposed by Mr. Hurd for the development and workings of the coal field lying inside of the present or No. 2 Mine consists in running two parallel drivages or slopes for a distance of from 2,600 to 3,000 feet into the virgin coal field, starting at a point in the lower Beaver's Deeps workings. From the end of these drivages, levels and counters would be driven off in either direction. After leaving solid pillars of 300 feet on either side of drivages, 900-feet panels would be opened up towards the old workings, opened up for a distance of 1,000 feet above the levels by four inclines 300 feet apart. From these inclines rooms would be set off, starting from the top of incline, to be immediately followed by the extraction of pillars in the upper rooms, simultaneously with the completion of the lower rooms. This extraction of pillars would continue to within 300 feet of the level, when a 300-feet pillar would be left to protect the level. Between one panel and the next there would be left a solid pillar of 200 feet.

"This proposed plan is, of course, dependent on the finding of suitable coal in the new field, and, therefore, for the present, the work being done is prospecting work only.

"The roadway from the tunnel mouth to the beginning of the new drivages would be made through the old workings of Beaver's Deeps, which, as yet, have shown no sign of weakness and will, in all probability, be found safe. If not so found, it may be necessary to drive independent tunnels from Coal Creek valley to connect with the new drivages, possibly through an underlying seam.

"I might say that Mr. Hurd has already started to establish this system of workings in all the company's collieries. Properly carried out, the proposed system would seem to correct many of the troubles met with in these mines, and is a substantial guarantee that the company is determined to abandon the—to a certain extent—make-shift policy which has been forced on it by circumstances, and to adopt a systematic plan of exploitation which will assure the safety of the mine and of the mine workers.

"The cost of this change will be great, both in the outlay of money and the curtailment of production for the next year or two. Some future regulations may have to be made as to the height of these new drivages, so as to guarantee they would not be completely closed up by raising of the pavement. There is also some question as to whether the extraction of pillars from the panels, as planned by Mr. Hurd, might not induce 'bumps' as in the present case, and also whether it will be practicable to maintain such long single inclines in the panels ; but the scheme given is only an outline and subject to variations as conditions demand."

This report shows, not only the danger to life arising out of the leaving in of pillars of insufficient size, but also the loss of 50 per cent of the coal in the pillars which could not be extracted.

Description of Mines

In the following description* of the different mines free reference is made to Inspector Evan's report :†

No. 5 Mine.

This mine is situated on the north side of the valley and is opened by means of three tunnels. The main tunnel is about 4,200 ft. in length, and is practically on the same elevation as the tipple, 3,800 ft. distant. No. 1 and No. 2 slopes are driven to the dip from the main tunnel at 1,550 ft. and 2,450 ft. respectively from the entrance.

Method of Working.—The coal to the rise of the tunnel is worked from No. 4 south tunnel which is 2,300 ft. in length and

* On account of a miners' strike, the writer did not examine the underground workings of these mines.

† Annual Report of Minister of Mines, B.C., 1912.

Steel Tipple, Crowsnest Pass Coal Co., Coal Creek, B.C.

Beehive Coke Ovens, Crowsnest Pass Coal Co., Fernie, B.C.

350 ft. above the main tunnel; No. 19 and No. 21 inclines are driven to the rise from this tunnel about 1,040 ft. and 1,700 ft. respectively, from the entrance. The coal from this level is lowered over a gravity-plane 1,100 ft. in length to a point about one mile from the tipple. The coal is hauled to the tipple by means of steam locomotives.

The seam varies from 8 ft. to 16 ft. in thickness and is worked on the pillar-and-room system. Levels are turned off the slopes and inclines 250 ft. apart. The rooms are driven up the pitch 14 ft. wide. The room pillars vary from 40 ft. to 60 ft. in width, depending on the thickness of the seam and the nature of the roof. All rooms and levels are timbered with framed sets.

Haulage.—Tail-rope and direct haulage are used on the inclines and slopes; haulage on the main levels is by compressed-air locomotives.

Ventilation.—The mine is ventilated by a belt-driven Chandler fan 16 ft. x 4 ft. 8 in., delivering 127,000 cu. ft. of air per minute. The water gauge is 2.2 inches. The fan engine is 16 in. x 18 in.

Blasting Methods.—Shot-firing is confined to a few places only. Shots are fired by battery, and permitted explosive only is used. Safety lamps are used exclusively underground.

No. 9 Mine

This mine is situated on the north side of the valley about 400 ft. distant from the tipple. The entrance is by two adit tunnels ; the main tunnel, 14½ ft. x 7 ft. and 3,350 ft. in length, is used for haulage and the second tunnel, 12 ft. x 7 ft., serves for ventilation. The workings are carried from No. 3 incline which is driven to the rise from a point 2,920 ft. from the mouth of the tunnel.

Method of Mining.—The method of mining is longwall. Levels are turned from the incline 200 ft. apart, and gate roads are turned from the levels at 40 ft. centres. Cogs are set along the side of the roadways 4 ft. apart and packed with rock from the roof.

Ventilation.—The mine is ventilated by an 8 ft. x 16 ft. fan, delivering 54,000 cu. ft. of air per minute. The water gauge is 1.2 inches.

Haulage.—The coal is conveyed from the bottom of the incline to the tipple by means of compressed-air locomotives.

Blasting Methods.—Shot-firing is allowed in rock work but the shots are fired during the night shift. Wolf safety lamps are used exclusively underground.

No. 1 North Mine

This mine is situated on the north side of the valley and at the elevation of about 300 ft. above the tipple. It is opened up by a tunnel 1,800 ft. in length. The coal from the main tunnel is lowered

over a gravity-plane 3,000 ft. from the tipple. The seam varies from 8 ft. to 35 ft. in thickness but only the lower portion of the seam is worked. No. 2 and No. 3 inclines have been driven to the rise 1,000 ft. apart.

Method of Mining.—The method of mining is pillar-and-stall. In No. 2 incline, rooms are turned off the incline 60 ft. apart and cross-cuts are driven 60 ft. apart. In No. 3 incline district the rooms are driven 150 ft. apart and cross-cuts are driven 80 ft. apart.

Ventilation.—The mine is ventilated by a 5 ft. x 2 ft. fan, belt driven from a 25 h.p. electric motor and delivering 38,000 cu. ft. of air per minute.

Haulage.—The cars are hauled from the face to the incline by means of horses and are lowered down the inclines by tail-rope system.

Blasting Methods.—Shot-firing is confined to No. 2 incline district. Gas has been found in the mine and Wolf safety lamps are used exclusively underground.

No. 1 South Mine

This mine is situated 2,500 ft. south-west of the tipple and 250 ft. vertically above it. The entrance is by means of two adit tunnels, about 1,800 ft. in length, driven on the strike of the seam. The main incline, 900 ft. in length, is driven to the rise of the main tunnel from a point 1,300 ft. from the entrance.

The seam averages 30 ft. thick but 10 ft. of the upper portion of the seam only is worked.

Method of Mining.—The system of mining is pillar-and-room. Rooms are turned off the incline 150 ft. apart ; crosscuts are driven from 60 ft. to 150 ft. apart.

Ventilation.—The mine is ventilated by a 5 ft. x 2 ft. fan, belt driven from a 25 h.p. electric motor and delivering 22,500 cu. ft. of air per minute.

Haulage.—The cars on the incline are lowered to the main tunnel by tail-rope haulage, and conveyed to the mouth of the tunnel by horse haulage, thence lowered by gravity-plane to the main tramroad from where they are hauled to the tipple by electric locomotives.

Shot firing is prohibited in this mine and Wolf safety lamps are used exclusively underground.

No. 2 Mine

This mine is situated immediately at the south end of the tipple. The workings are in two districts—No. 1 or High Line district and No. 2 or Rock Tunnel district.

In No. 1 district the workings are in the upper part of the incline which has been driven up the pitch of the seam from a point 1,400 ft. from the entrance of the tunnel. In No. 2 district the workings are from a slant which was driven from the tunnel at a point 1,450 ft. from the entrance.

Method of Mining.—The seam varies from 7 ft. to 25 ft. in thickness and the method of mining used in both districts is pillar-and-room.

Ventilation.—The mine is ventilated by a 16 ft. x 8 ft. fan having a capacity of 130,000 cu. ft. of air per minute against a 3-in. water gauge.

Shot-firing is confined to the upper part of No. 1 district, and Wolf safety lamps are used exclusively underground.

No. 3 Mine

This mine is situated about 100 ft. east of No. 2 mine tunnel; the entrance is by means of a slope 2,250 ft. in length, driven on the pitch of the seam. At a point on the slope about 1,450 ft. from the entrance, No. 2 south level has been driven for a distance of 1,950 ft.

Method of Mining.—The coal seam is the same as that worked at No. 2 mine; it is of good quality and from 3 ft. to 4 ft. thick. The system of mining is longwall. Levels are turned off on both sides of the slope, 200 ft. apart. About 125 ft. from the slope, slants are driven half across the pitch from the levels. Gate roads are driven off the slants at 40 ft. centres. Cogs are set along the side of the roads 4 ft. apart, and the gob is filled and packed from the floor-brushings.

Ventilation.—The mine is ventilated by a 16 ft. by 8 ft. Wilson fan, belt driven from a 16 in. by 18 in. steam engine, and delivering 132,400 cu. ft. of air per minute, with 1.9 in. water gauge. This fan also ventilates No. 1 East Mine.

Haulage.— The coal is hoisted to the levels by means of air hoists and conveyed to the slope by means of horse haulage, whence it is raised to the surface by means of an electric hoist.

Shot-firing is carried on in this mine and Wolf safety lamps are used exclusively underground.

No. 1 East Mine

This is a comparatively new mine and is situated 800 ft. to the east of the tipple. The entrance is by means of a rock cross-cut tunnel, 18 ft. by 8 ft. and 215 ft. in length. The mine is developed by a pair of entries 1,800 ft. in length driven to the south. A diagonal entry 1,500 ft. in length and a main dip are now being driven

Method of Mining.—The system of mining is pillar-and-stall; the rooms and cross-cuts are arranged so as to leave pillars 150 ft. by 300 ft.

Ventilation.—The mine is ventilated by the same fan as ventilates No. 3 mine. The main return airway is a rock tunnel driven from No. 2 dip entry.

Haulage.—The haulage from the main dip is by a 75 h.p. electric hoist. The cars from the mine are lowered to the tipple by means of a gravity-plane 800 ft. in length.

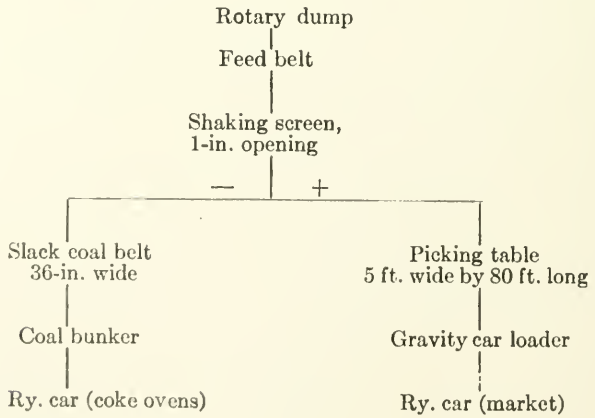
Portions of the mine are wet and shot-firing is carried on in some places. Wolf safety lamps are used exclusively underground.

In timbering the mines, three lineal feet of props are used per ton of coal mined Owing to the great pressure that it has to withstand, it is necessary to use a good grade of timber.

Green timbers are used for stringers, but any timber may be used for ordinary posts. Owing to some of the forests being burned by the Fernie fire, the price of timber has increased twenty-five per cent.

Tipple.—The coal from the different mines is screened on the same tipple. The tipple is of steel construction 840 ft. in length, and is equipped with two sets of double tracks and rotary dumps ; one set being used for the north side coal and one set for south side coal. The tipple is also equipped with the necessary screens and picking belts for sizing and cleaning the coal.

The following diagram shows the method of screening and loading the coal :



All the fine coal which passes through a one-inch screen is shipped to Fernie, where it is converted into coke in beehive ovens. An extraction of about 65 per cent of coke (by weight) is obtained, but, as

the ovens are not of the by-product type, the gas, tar and ammonia are wasted.

Power Plant.—The main battery of boilers consists of :

Seven 150-h.p. return tubular boilers
Five 112-h.p. Mumford boilers
One 100-h.p. water-tube boiler.

Mine Equipment.—The following air compressors are used to furnish power for locomotive haulage, pumping and hoisting :

One four-stage cross-compound Corliss condensing air compressor, capacity 1,750 cu. ft. of air per minute.

The following table gives the sizes of cylinders and the pressures used :

	Diameter of Cylinder	Length of Stroke	Gauge Pressure
High-pressure—steam	17 in.	36 in.	100 pounds per sq.in.
Low-pressure—steam	24 "	36 "	15 " " " "
First stage—Air	24 "	36 "	25 " " " "
Second stage—Air	12 "	36 "	100 " " " "
Third stage—Air	10¼ "	36 "	350 " " " "
Fourth stage—Air	5¼ "	6 "	1200 " " " "

One two-stage cross-compound Corliss condensing air compressor, compressing to 80 pounds per sq. in.; capacity 3,500 cu. ft. per minute. Steam cylinders, 24 in. and 36 in. by 48-in. stroke; air cylinders, 36 in. and 24 in. by 48-in. stroke. One duplex steam and compound air compressor compressing air to 80 pounds per sq. in.; capacity 1,300 cu. ft. of air per minute.

The electric machinery consists of two steam engines, size of cylinders 20 in. by 20-in. stroke, belted to four 100-k.w. (250 v.) direct current generators.

Locomotives.—The following air locomotives are used for underground haulage :

Two duplex air locomotives ; size of cylinders 6 in. by 10-in. stroke.

One duplex air locomotive ; size of cylinders 8 in. by 14-in. stroke.

One compound air locomotive, size of cylinders, 5½ and 10 in. by 12-in. stroke.

Thirteen air hoists are also used for underground haulage.

The following steam locomotives are used for outside haulage between No. 5 and No. 1 mines and the tipple :

One duplex steam locomotive, size of cylinders 14 in. by 18-in. stroke.

One duplex steam locomotive, size of cylinders 10 in. by 12-in. stroke.

One 60-h.p. electric locomotive is used for haulage between No. 1 South mine and the tipple.

Two 60-h.p. electric hoists are used for hoisting coal from No. 1 and No. 3 mines.

In addition to the foregoing, the mine plant is also equipped with the necessary machine shops for doing ordinary mine-repair work.

The tipple has a capacity for handling an output of 6,000 tons per day, but the actual daily output is about 2,500 tons. The following are the official returns of output for the year 1912 :

COAL CREEK COLLIERIES, 1912*

Sales and Output for Year	Coal		Coke	
(Tons of 2,240 lbs.)	Tons	Tons	Tons	Tons
Sold for consumption in Canada	55,294	.....	107,418	.....
" export to United States	384,658	.....	41,952	.....
" " to other countries	.....	.....	.....	.....
Total sales	.....	439,952	.....	149,370
Used in making coke	221,363	.....	.....	.....
" under colliery boilers, etc	35,537	.....	.....	.....
Total for colliery use	.....	256,900	.....	.....
		696,852		
Stocks on hand first of year	111	.....	446	.....
" " " last of year	103	.....	.....	.....
Difference added to stock during year	.....		.....	446
Output of collieries for year	.....	696,844	.....	148,924

Number of Hands Employed, including Fernie Coke-ovens

Character of Labour	Under-ground	Above Ground	Totals
	No. employed	No. employed	No. employed
Supervision and clerical assistance	36	8	44
Whites—Miners	493	....	493
Miners' helpers	....	....	....
Labourers	122	135	257
Mechanics and skilled labour	305	163	468
Boys	25	6	31
Totals	981	312	1,293

*Annual Report of Minister of Mines of British Columbia, 1912.

Michel Collieries

The Michel coal-field is situated in the northern portion of the Crowsnest coal-field. The measures are exposed along the valley of Michel creek, which cuts across the coal-field. The colliery is situated at Michel, a station on the Canadian Pacific railway.

Seams have been worked on both sides of Michel Creek valley by the Crowsnest Pass Coal Company. The following mines are in operation :

South Side.—

No. 3 Mine. This is the upper seam and the coal varies in thickness from 7 ft. to 14 ft.

No. 4 Mine. This seam is situated 80 ft. below No. 3 and averages about 12 ft. in thickness.

No. 5 Mine. This seam is situated about 150 ft. below No. 4 and averages 7 ft. in thickness.

North Side.—

No. 8 Mine. This is the upper seam on the south side, but its position has not been correlated with the north side coal seams. It varies from 10 ft. to 12 ft. in thickness.

No. 7 Mine. This seam is situated about 80 ft. below No. 8 seam and is about 6 ft. in thickness.

The general dip of the seams at Michel is about 18° to the south. The seams are often broken by faults, and rolls are frequently encountered in the workings.

The coal on the south side of the valley has been opened up by means of a crosscut tunnel, 1200 ft. in length, which cuts Nos. 3, 4 and 5 seams in the order named.

As the coal-seams dip at an angle of about 18° to the south, all the coal on this side of the valley has to be hauled up the slopes by hoist. It is hauled from the face to the bottom of the slopes by horse. Horse haulage is also used in the main crosscut tunnel, but the Company intend to install an endless-rope system of haulage in the main tunnel.

No. 5 Mine

Method of Mining.—This seam averages 7 ft. in thickness and is worked by pillar-and-stall method. The main entries are driven 12 ft. wide and the side entries 10 ft. wide. The rooms are 16 ft. wide and vary from 250 to 300 ft. in length. The room pillars are 50 ft. in width. Very few pillars have been drawn.

Gas has been found in the mine and Wolf safety lamps are used exclusively underground.

Some blasting is done in the first west level. No. 6 detonators and electric battery are used for firing the shots.

VENTILATION.—The mine is ventilated by means of a 10 ft. x 4 ft. fan. There are two air splits in the ventilation system : West side split, 23,000 cu. ft. of air per minute ; East side split 42,600 cu. ft. of air per minute.

No. 4 MINE

This seam averages about 11 ft. in thickness, but, owing to a shale parting, 3 ft. of top coal is left in. This seam is worked by pillar-and-stall methods similar to those used in No. 5.

No. 3 MINE

METHOD OF MINING.—In this mine, which is the third seam reached by the crosscut tunnel, the coal varies from 6 ft. to 14 ft. in thickness. The seam was formerly worked by pillar-and-stall, and after experimenting with the longwall method for a time has been changed to pillar-and-stall. No blasting is carried on and Wolf safety lamps are used underground.

VENTILATION.—No. 3 and No. 4 mines are ventilated by a Guibal fan, 16 ft. by 8 ft., situated at the outlet of No. 4. The total quantity of air delivered is about 117,000 cu. ft. per minute, with a water gauge of 2.5 in. The air is divided into three splits, two of which ventilate No. 3 mine and one ventilates No. 4. The distribution of the air is as follows :

No. 3 mine, East side split—41,600 cu. ft. per minute
West side split—37,200 " " "
No. 4 mine .....—35,000 " " "

The mine makes gas from the roof and coal. The percentage of gas in the return air from No. 3 and No. 4 mines is one per cent and one and one-half per cent, respectively.

No. 8 MINE

METHOD OF MINING.—This mine is situated on the north side of the valley and is opened up by adit level. The seam varies from 10 ft. to 12 ft. in thickness and is worked by pillar-and-stall method. All the workings are to the rise. The stalls are driven to the rise 16 ft.

wide, and the pillars left are 50 ft. in width. The coal is lowered to the bottom of the inclines by means of compressed-air hoists, which also haul up the empty cars. From the inclines the coal is hauled to the tipple by means of compressed-air locomotives.

The use of explosives in coal is confined to the west side of No. 3 incline, and is done at night only. This district is near the outcrop and is very damp. The explosive used is Monobel with electric detonators.

Ventilation.—Ventilation is produced by a Walker rope-driven fan, 20 ft. x 7½ ft., driven by a 13 in. and 23 in. by 30 in. tandem compound condensing engine. The quantity of air produced is 180,000 cu. ft. per minute at 138 r.p.m. with a 4 in. water gauge. This fan is used to ventilate No. 7 and No. 8 mines.

There are three splits in the ventilation system, the quantity of air being distributed as follows : Slope district, 28,800 cu. ft. per minute ; No. 17 chute district, 14,400 cu. ft. per minute ; No. 3 incline district, 15,000 cu. ft. per minute.

The mine makes gas from the roof and coal, the gas in the return air-way averaging about 2 per cent. It has been on fire and has been sealed since May, 1911.

No. 7 Mine

Method of Mining.—This mine is opened up by a crosscut tunnel driven from a point in No. 8 mine about 2,000 ft. from the portal. The seam, averaging about 6 ft. in thickness, is worked by the single stall method. Levels are driven east and west on the strike of the seam from which inclines 500 ft. apart are driven to the rise. Stalls 16 feet wide are opened off the inclines and driven parallel to the levels, leaving pillars 30 ft. in width. As soon as the stalls have been driven, the pillars are drawn and the roof allowed to settle. Fifty per cent of the timber is recovered and used again.

The haulage in this seam is similar to that in use in No. 8 mine.

Very little powder is used and the blasting in coal is confined to the west side and to the new slope on the east side.

Ventilation.—The mine is ventilated by the same fan as is used in No. 8 mine. There are two splits in the ventilation system : East side split, 10,400 cu. ft. a minute for 35 men and 2 horses ; West side split, 7,000 cu. ft. per minute for 32 men and 2 horses.

Output.—The Michel colliery has a capacity of 6,000 tons per day, but the actual average output is about 2,000 tons. The following are the official returns for the year 1912 :

MICHEL COLLIERIES, 1912

Sales and Output for Year	Coal		Coke	
(Tons of 2,240 lbs.)	Tons	Tons	Tons	Tons
Sold for consumption in Canada	11,253	.....	61,112	.....
" " export to United States	119,592	.....	8,305	.....
" " " to other countries	.....	.....	.....	.....
Total sales	.....	130,845	.....	69,417
Used in making coke	102,961	.....	.....	.....
" under colliery boilers, etc	19,971	.....	.....	.....
Total for colliery use	.....	122,932	.....	.....
		253,777		
Stocks on hand first of year	18	.....	161	.....
" " " last of year	103	.....	774	.....
Difference added to stock during year	.....	85	.....	613
Output of colliery for year	.....	253,862	.....	70,030

Number of Hands Employed, including Coke-ovens

Character of Labour	Underground		Above Ground		Totals	
	No. employed	Average daily wage	No. employed	Average daily wage	No. employed	Average daily wage
Supervision and clerical assistance	12	....	7	....	19	....
Whites—Miners	224	....	....	....	224	....
Miners' helpers	....	....	....	....	....	....
Labourers	17	....	71	....	88	....
Mechanics and skilled labourers*	88	....	45	....	133	....
Boys	....	....	1	....	1	....
Japanese	....	....	....	....	....	....
Chinese	....	....	....	....	....	....
Indians	....	....	....	....	....	....
Total	341	....	124	....	465	....

Tipple.—The coal from the north and south sides is conveyed to a common tipple. The tipple is of steel construction 664 ft. long, 14 ft. wide, and extends across Michel Creek valley.

*Note.—Mechanics and skilled labour include : Underground—drivers, motormen, rope-riders, hoistmen, trackmen, bratticemen, timbermen, pumpmen, fanmen, and carpenters Above ground—lampmen, weighmaster, tipplemen, firemen, machinists, carpenters, blacksmiths, engineers, and electric-plant, and plumbers.

The cars from No. 3, No. 4 and No. 5 mines enter a cradle on the south side of the tipple and are conveyed by car-haul to a rotary self-dumping device. After the coal has been discharged, the empties return to the mine entrance by an overhead track.

The loaded cars from No. 7 and No. 8 mines are conveyed to the tipple by air locomotives and dumped by means of a Green's patent dump, the empties returning to the north side by a track situated below the level of the main tunnel. The empty-car track joins the loaded-car track at a point 300 ft. from the portal. The coal is first screened on 1 in., 2 in., or 3 in. shaking screens and the impurities picked out on a picking table. The fines are conveyed by belt-conveyer to the coke-oven bins. The screened coal is loaded into box cars, by Smith gravity box-car loaders or into gondolas.

Power Plant.—The power plant consists of the following :
Boilers on north side—Three 105-h.p. return tubular boilers
" " south side—Eight 105-h.p. " " "
Three 131-h.p. locomotive-type boilers
Total horse-power in boilers—1548.
Electric generators—Two 250 k.w. direct current generators.

Air Compressors—One cross-compound Corliss condensing air compressor, compressing air to a gauge pressure of 100 lbs. per sq. in.; capacity, 3,500 cu. ft. of free air per minute. The sizes of the steam and air cylinders are as follows :

Steam Cylinders	Air Cylinders
High-pressure—26 x 48 in.	22 x 48 in.
Low-pressure—45 x 48 "	37 x 48 "

One cross-compound Corliss condensing air compressor, capacity, 4,500 cu. ft. of free air per minute. Size of steam cylinders—22 in. and 40 in. by 48 in. stroke; air cylinders—22 in.and 36 in. by 48 in. stroke. These compressors are used to furnish power for mine haulage and other purposes.

One four-stage cross-compound Corliss condensing air compressor is used to furnish power for high-pressure locomotive haulage ; capacity, 1,450 cu. ft. of free air per minute ; gauge pressure, 1,200 lbs. per sq. inch. The sizes of the cylinders are as follows :
Steam cylinders —18 in. and 34 in. by 36 in. stroke
Air cylinders—First stage, 22 in. by 36-in. stroke
Second " 12½ " " " "
Third " 10½ " " " "
Fourth " 5½ " " " "

Steam Engines—Two tandem compound condensing slide-valve engines, size of cylinders 19 in. and 32 in. by 22-in. stroke, and 18 in. and 31 in. by 24-in. stroke. Each engine is direct-coupled to a 250-k.w. generator.

Five air locomotives are used for haulage in No. 7 and No. 8 mines.

Compressed Air Hoists.—Two Jenckes hoists, 12 in. x 15 in. stroke, and two Ledgerwood hoists, 12¼ in. x 15 in. stroke, are used for haulage in No. 3, No. 4 and No. 5 mines.

One Ledgerwood hoist 12¼ in. x 15 in. stroke and one Jenckes hoist, 12 in. x 15 in. stroke, are used for haulage in No. 7 mine. One Ledgerwood hoist, 12¼ in. x 15 in. stroke, and six Sampson hoists, 6 in. x 8 in. stroke, are used for haulage in No. 8 mine.

Coke Ovens.—All the slack coal is coked in beehive coke ovens. The plant consists of 480 five-ton ovens. In 1910, 147,134 tons of coal were converted into 94,356 tons of coke; in 1911, 70,351 tons of coke were produced.

Mining, like other industries, is a commercial enterprise and unless the timber can be had at a reasonable price, the operators will be forced to use inferior timber and in this way endanger life and also obtain a lower extraction of coal from the mines. When one considers that the coal content of this field has been estimated at over twenty-two and one-half billion tons, it can be seen what enormous quantities of timber will be required for mining purposes. The natural remedy is to protect the forests from forest fires and to encourage the reproduction of the "second growth" over burned areas.

NICOLA VALLEY COAL-FIELD

Diamond Vale Coal Company

This company's property is situated about one mile above Merritt, a town on the Nicola Valley branch of the Canadian Pacific railway.

Three seams have been prospected on the property. The upper seam is 4 ft. 6 in. in thickness and is separated from the next—No. 3—by 150 ft. of measures. The other seam, 13 ft. in thickness, was prospected by a bore-hole drilled one mile north-east of No. 3 mine, the coal being encountered at a depth of 600 ft. No. 3 seam outcrops on the hill just above the mine spur track from Merritt. A slope, 425 ft. long, has been driven on the dip of the seam, which is 37° at this point. East and west levels have been driven at right angles to the main slope at distances of 300 ft. and 400 ft. from the surface, respectively. The east level is 600 ft. in length and the west level 400 ft.

Method of Mining.—The system of mining is double-stall. Chutes are driven up the pitch with pillars 36 ft. wide in between.

Thirty feet above the level two rooms 18 ft. wide are opened off between a pair of chutes and driven to the surface. Pillars 36 ft. wide are left between the double stalls. No pillars have been removed and an extraction of about 45 per cent has been obtained.

Ventilation.—The mine is ventilated by means of a fan delivering 8,000 cu. ft. of air per minute. The air is taken down the main slope and passes along the west level and up the stalls and is carried across to the east level by an overcast, through the rooms on the east side, to the return airway.

Gas has been found in the mine and safety lamps only are used.

The mine has a capacity of 50 tons of coal per shift, but the actual average is 30 tons per day. In 1912 thirty men were employed underground and fourteen above ground.

In timbering, one lineal foot of props is used per ton of coal mined.

Blasting Methods.*—The coal is undermined by hand and the shooting is done by means of fuse and thirty per cent dynamite. Very little shooting is done in the coal.

Mine Equipment.—The surface plant consists of a wooden tipple, but all the output is shipped as run-of-mine.

The power plant consists of a 30-h.p. boiler and a small second motion hoist used for hoisting the coal out of the slope.

Inland Coal and Coke Company

This property is situated on a hill about a mile south-west of No. 1 Mine tipple, Middlesboro colliery. Four seams of coal have been found.

No. 1 seam, about 4 ft. thick, has been prospected by a slope 300 ft. in length. No. 2 seam, about 6 ft. thick, has been prospected by a slope 500 ft. in length ; No. 3 seam, 10 ft. thick, has been developed by a slope 600 ft. in length ; No. 4 seam, 14 ft. thick, has not been thoroughly prospected.

They have a dip of 30° to the south. The lowest seam, No. 3, has been more extensively developed than the others. Levels have been driven from this slope with a bearing N. 50° W.

Method of Mining.—The method of mining is to drive chutes, 24 ft. wide, up the pitch from the levels. Pillars, 50 ft. wide, are left between the chutes. The roof is a good, hard sandstone. The coal is loaded into cars at the chutes and trammed on the main level by pushers. The cars are hoisted to the surface by means of a second motion hoist, size of cylinders, 8 in. x 10 in. The coal is lowered from the mine to the tipple by means of a gravity plane 1760 ft. in length. The tipple is connected with the Canadian Pacific railway by means of a spur 1 mile long.

*Since an explosion which occurred in March, 1912, blasting is permitted only in rock work.

Nicola Valley Coal and Coke Company

This company is operating five mines, Nos. 1, 2, 3, 4 and 5, all of them being situated near the town of Middlesboro. Nos. 1, 4 and 5 are situated on the west side of the valley, about half a mile distant from No. 2 and No. 3 mines. The two groups of mines are equipped with separate tipples but are connected by a common spur line which joins the Canadian Pacific railway near the town of Merritt.

The coal seams of the two groups have not been correlated with one another, but the following table shows the thickness of the seams.

East group	West group	Inland Coal & Coke Co.
No. 2 Mine seam, 4ft. 8in.	No. 4 Mine seam—14 ft.	No. 1, seam— 4 ft.
No. 3 " " 2 ft. 6in	No. 5 " " 5 "	No. 2 " 6 "
	No. 1 " " 18 "	No. 3 " 10 "
		No. 4 " 14 "

No. 1 Mine*

Method of Mining.—This mine is opened up by a main level, 1,700 ft. in length, driven with the measures. The seam is 18 ft. in thickness. The dip varies from 20° to 38° to the south.

About 190 ft. from the portal, No. 1 slope has been driven down the pitch for a distance of 480 ft. There are very few workings on this slope.

About 530 ft. from the portal old No. 1 slope enters the main level. Above this, to the rise, the coal has been worked extensively and the removal of too much coal from the pillars has resulted in a "squeeze" on the level and air-ways, necessitating re-timbering a portion of the mine.

About 820 ft. from the portal, No. 2 slope has been driven for a distance of 575 ft. and the coal mined on both sides of the slope by bord-and-pillar system. The bords are 16 ft. wide and the pillars 40 ft. by 50 ft.

Gas has only been found in the roof and mixed lights are used. In timbering, four lineal feet of props are used per ton of coal mined.

The coal is mined and picked down at the face. Thirty per cent dynamite is used in coal and 40 per cent dynamite for brushing the roof or floor.

The mine is ventilated by means of a 2 ft. x 5 ft. fan delivering 25,000 cu. ft. of air per minute.

Mine Equipment.—The coal is hauled to the tipple by horses. A Stuart washer, capacity 45 tons per hour, is constructed near the tipple. The method of washing and screening the coal is as follows : The

* This mine was closed down on account of fires which broke out on March 22nd, 1912.

PLAN OF No. 2 MINE NICOLA VALLEY COAL & COKE Co., Ltd.

Scale 400 feet = 1 inch

coal is first screened over a shaking screen, 32 ft. long, with 2-in. perforations. The oversize goes to the lump-coal bin and the undersize to a Stuart washer. The washed coal is then passed to a flushing tank with $^{5}/_{8}$ in. perforations. The slack coal passes to a settling tank and thence to the slack coal bins. The oversize is screened over a ¾-in. screen and the nut and pea coal conveyed to their respective bins. The washery is arranged with by-passes so that the different sizes of washed and screened coal may be mixed together. The tipple and washery will be able to handle the outputs from Nos. 1, 4 and 5 mines direct. The coal from No. 2 and No. 3 can be delivered to it by rail.

No. 4 Mine

Method of Mining.—The entrance to this mine is by slope situated 310 ft. above the entrance of No. 1 mine. The seam has a thickness of 14 ft. and dips 25° to the south. The main slope, on encountering a fault at about 525 ft. from the portal, was continued down the dip at an angle of about 30° to the east of its former direction. The main slope is 1,200 ft. in length. The present practice is to drive the rooms as levels off the main slope every 80 ft. The room width is 16 ft. and crosscuts are driven between the rooms, forming pillars 60 ft. by 80 ft.

Gas is seldom found but safety lamps are used underground.

The coal is undercut by hand and the blasting is done by means of Monobel powder fired by electric detonators. Forty per cent dynamite is used in rock work and for brushing the roof and floor. The tamping material is clay and dirt dug in the mine.

Output.—The mine has a capacity of 600 tons per day, but the actual average is about 350 tons. It is worked by three shifts and there are 105 men employed underground and 4 above ground.

The coal was delivered to the tipple level by means of a long chute, which broke up the coal and increased the percentage of slack. To obviate this, the company has driven a rock crosscut tunnel from No. 5 mine to cut No. 4 mine seam some distance down the dip.

Ventilation.—The mine is ventilated by means of a small Sheldon fan. There are two splits in the ventilation system ; the main slope is the intake airway and the air is split at about 725 ft. from the portal. One split ventilates the bottom of the slope and the east side workings and returning to the fan by an overcast over the main slope ; the other ventilates the west side.

No. 5 Mine

Method of Mining.—The entrance to this mine is on the same level as No. 1 and situated a short distance from it. No. 5 seam is 5 ft. thick and overlies No. 1 seam, 80 ft. of strata separating them. It is

opened up by a main level, 1,600 ft. in length and rooms have been turned off the level to the rise. A rock tunnel, driven from the main level to cut No. 4 seam, is used as a main haulage road for the two mines.

No. 1 dip is 164 ft. long and branches off the main level at about 620 ft. from the portal. No. 2 dip is about 190 ft. long and branches off the main level at 1,400 ft. from the portal. Ordinary rooms have been opened off the counter level and driven to the rise.

The mine is ventilated by a fan 38 in. x 18 in. delivering about 8,500 cu. ft. of air per minute.

No. 2 Mine

This mine is situated about half mile east of No. 1. It is opened up by a main level, 1,750 ft. in length and a slope 1,200 ft. in length. The level and slope are connected at the portal.

The coal to the rise of the tunnel has been worked out. Between the slope and the main level it has been worked by levels to the right of the slope. No. 7 level is connected with the slope 750 ft. from the portal and extends parallel to the main level for a distance of 1,700 ft. From No. 7 to the rise the coal has been worked by means of chutes and crosscuts. The seam is about 5 ft. thick and dips 20° to the northeast.

The roof is a hard sandstone which stands well. The practice is to drive the stalls 40 ft. wide and to pack the sides with dirt and rock to keep the roof up. Crosscuts are driven connecting the stalls every 40 ft. to 50 ft. The pillars vary in width from 20 ft. to 40 ft.

No. 3 Mine

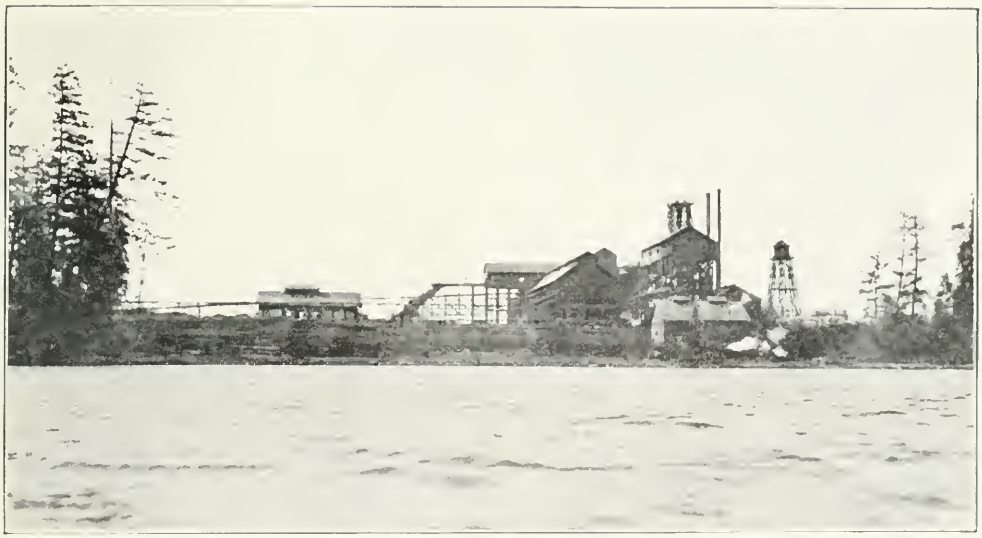
No. 3 mine seam is situated about 150 ft. below No. 2, to which it is connected at No. 4 chute main level by a rock tunnel 328 ft. long. The seam is 2½ ft. thick and of good quality. This mine is opened up by a level about 1,000 ft. in length.

VANCOUVER ISLAND COAL FIELD

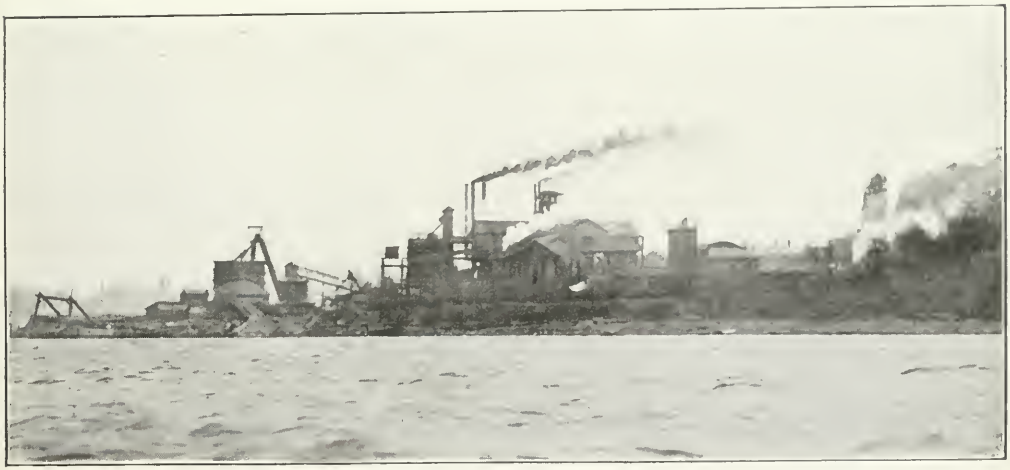
Western Fuel Company

This Company owns the mineral rights under 43,000 acres of land in the vicinity of Nanaimo. Of this area, 17,000 acres have been proved to contain coal, and the Company estimates the tonnage at 100,000,000 tons.

There are, at present, two mines in operation, No. 1 Shaft and Northfield Mine. The Company are sinking a new shaft, 1,000 ft. deep, at the mouth of Nanaimo river. Another new mine is also being opened up near Chase river by a slope driven from the outcrop of the Douglas seam.



Pit-head, No. 1 Shaft, Western Fuel Co., Nanaimo, B.C.



Pit-head, Northfield Mine, Western Fuel Co., Nanaimo, B.C.

No. 1 Mine

Method of Mining.—This mine is opened up by a shaft 18 ft. in diameter and 640 ft. deep. The workings are under the waters of Nanaimo harbour, and beneath the surface of Protection and Newcastle islands. The workings from a shaft, 850 ft. deep, sunk on Protection island, connect with No. 1 mine workings and, since both these mines are ventilated in places by the same fan and ventilating system, they may be regarded as the same mine.

No. 1 shaft is used, almost entirely, as the working shaft, while the Protection Island shaft is used for lowering and hoisting the miners. The underground workings are very extensive, extending from face to face, for about six miles. The principal development entries are : No. 1 north level, No. 1 slope, diagonal slope, No. 7 east level and No. 2 and No. 3 slopes.

No. 1 north level is driven north from the bottom of the shaft for a distance of about three miles and serves as the main motor-haulage road for the north side coal. No. 2 slope is driven to the Newcastle seam from a point on the north level almost opposite Protection Island shaft. The coal in this seam varies in thickness from 30 in. to 3 ft. and is mined by longwall, being undercut by compressed air mining machines. It is known as north side coal, and is hard, clean and of excellent quality. It is hoisted up the slope to No. 1 north level on the upper seam and hauled along this level by electric locomotives to No. 1 shaft.

At a point on No. 1 north level, about 200 ft. from No. 1 shaft, No. 1 slope is driven to the dip for a distance of about 6,500 ft. The diagonal slope and No. 7 east level are driven off No. 1 slope at 3,000 ft. and 5,055 ft. respectively, from the top of the slope. No. 7 east level has been driven for a distance of about 6,000 ft. from No. 1 slope and forms the return airway for the diagonal slope workings. The face of this level is situated 1,200 ft. below the mud-flats of Nanaimo river. From the main landing on the diagonal slope, where the coal forms a basin, a 7 ft. by 10 ft. rock tunnel has been driven for a distance of 1,200 ft. to the other side of the basin, and thence for a further distance of 1,200 ft. in almost flat coal.

In the diagonal slope workings, the coal is mined by pillar and stall methods. The coal from the workings off the tunnel is hauled along the tunnel to the diagonal slope by tail-rope haulage, and thence up the diagonal slope to No. 1 slope, by a first motion engine stationed at the bottom of No. 1 shaft. The coal from No. 7 east level, and diagonal slope, is hauled up No. 1 slope to a point on the north level near the

bottom of No. 1 shaft by endless rope haulage. The coal is then hoisted to the surface through No. 1 shaft.

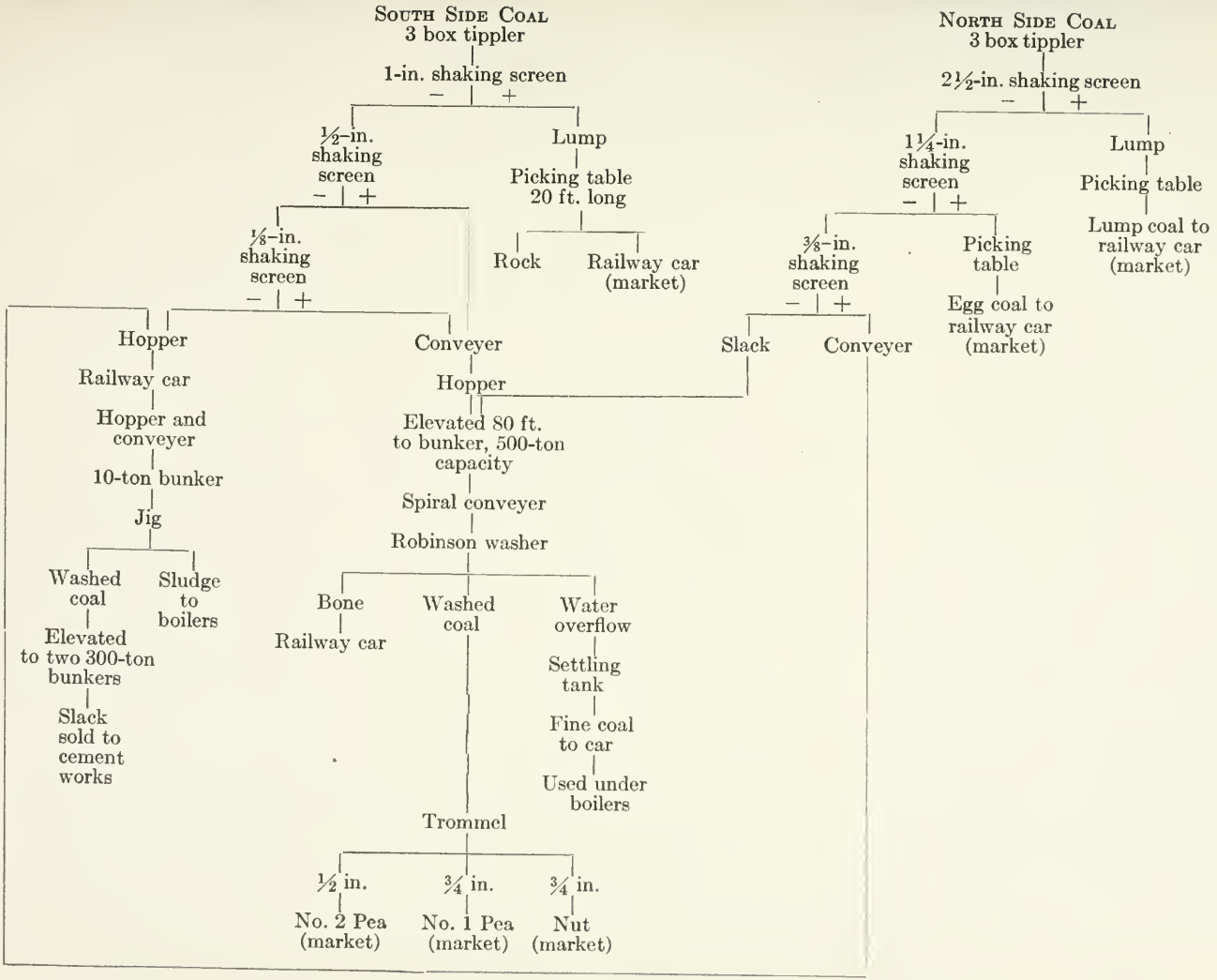
VENTILATION.—The following is a description of the fan used to ventilate the mine.*

For the past 18 years this mine has been ventilated by a large Guibal exhaust fan, 36 feet in diameter and 12 feet wide, with single inlet, running 45 revolutions a minute, producing a water gauge column of 2 inches. For the last few years this fan has been assisted by a blower Guibal fan, 20 feet diameter and 7 feet wide, running 75 revolutions a minute, with a 1¾-inch water gauge. These two fans combined produced at the uptake a total ventilation of 156,400 cubic feet of air a minute.

The management, taking into consideration how extensive the mine had already become, and with an eye to the future, decided to instal a new fan, and this has been done, the installation being completed on December 26th, 1908. This new fan, a Sirocco fan, was installed at No. 1 shaft without interfering with the big fan, which is being renovated and repaired, and will be held in reserve, or for emergencies. The new fan is a speed, double inlet fan, 90 inches outside diameter and 78 inches inside, connected by a 1½-inch hemp rope continuous drive with a 250-h.p. Robb-Armstrong Corliss valve engine, giving a speed ratio between the fan and engine of 4.25 to 1. The fan is set on reinforced concrete foundations, with steel housing, and is connected with the air shaft by two reinforced concrete drifts, each having a sectional area of 56 square feet. The fan will deliver 200,000 cubic feet of air a minute against a 4-inch water gauge. In a trial run in December, the engine running at 62 revolutions and the fan at 623 revolutions, a ventilation of 224,000 cubic feet a minute was produced, against a 5-inch water gauge. The mechanical horse-power developed by the engine was 200 h.p., and the mechanical efficiency of the fan was 88.25 per cent. The fan is so constructed that, should future development of the mine demand it, a second engine could be coupled to the other end of the shaft, and with such increased power the fan, running at 405 revolutions, is expected to be able to produce a current of air of 300,000 cubic feet against an 8-inch water gauge.

*Description by Archibald Dick. Report of Minister of Mines, B.C., 1908.

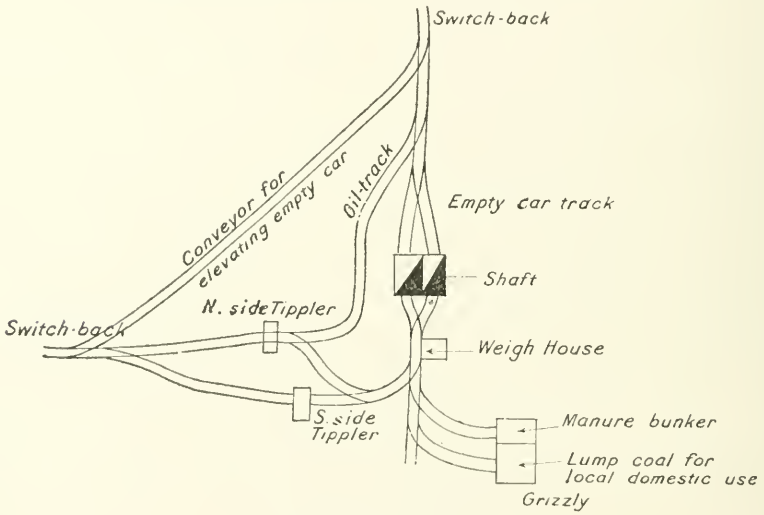
FLOW SHEET OF TIPPLE AND WASHERY.—The following diagram gives an outline of screening and washing operations :



Waste.—In the longwall workings very little of the coal is lost. The seam is about 3 ft. thick and the cover over the workings varies from 500 ft. to 800 ft. The roof is hard shale and the bottom hard clay. In pillar-and-stall work an ultimate recovery of from 60 to 80 per cent is obtained.

The sludge and other unmarketable coal from the coal washery is burned under boilers to produce power. The manager states that, in order to save nut and pea coal which had previously been used to generate power, two 84 in. by 16 ft. return tubular boilers were installed, and that, in one year, the economy thus effected paid the cost of the installation.

Surface Plant.—The following diagram shows the arrangement of tracks on the pit-head.



SKETCH SHOWING
ARRANGEMENT OF TRACKS AT PIT-HEAD,
WESTERN FUEL CO.

The coal is hoisted from the shaft in cars of 1,700 lbs. capacity, and delivered to the pit-head at the rate of four cars per minute. As indicated in the accompanying flow sheet, the north side, or coal from Newcastle seam, is kept separate from the south side coal during the screening and washing operations.

The power plant consists of :

Boilers—Two 170-h.p. water tubular boilers
" —Two 135-h.p. return " "
" —Two 106-h.p. " " "
" —Two 135-h.p. " " "

Air Compressors.—One cross-compound air compressor, size of steam cylinders 20 in. and 36 in. with 30-in. stroke ; air cylinders 20 in. and 32 in. with 30-in. stroke.

One cross-compound air compressor, size of steam and air cylinders 20 in. and 36 in. with 30-in. stroke.

These compressors compress air to 80 lbs. per sq. in., the air furnishing power for coal cutters, haulage and pumping machinery.

Electric Machinery.—The electric plant consists of two 16-in. by 16-in. Ball engines which are belted to two 75-k.w. direct current generators ; one 350-h.p. Corliss engine direct coupled to a 150-k.w. direct current generator, which is used to furnish power for mine haulage.

The following electric locomotives and hoists are used for underground haulage :

Three 7-ton Edison locomotives
One 10-ton Westinghouse locomotive
Two electric hoists ; and
One electric pump.

Power is also furnished for 700 lights. The company also possesses well-equipped machine shops, blacksmith shops and car shops, which are used to do ordinary repair and construction work and for building the mine cars. Steam locomotives and 7-ton cars are used for hauling the coal from the mine to the shipping wharves.

The following tables give the amount of coal produced and the number of men employed in No. 1 Shaft and Protection Island mines for the year 1912 :*

No. 1 SHAFT AND PROTECTION ISLAND MINES

Sales and Output for Year	Coal	
(tons of 2,240 lbs.)	Tons	Tons
Sold for consumption in Canada	224,589	.....
" " export to United States	100,399	.....
" " " to other countries	73,386	.....
Total sales	.....	398,374
Used under colliery boilers, etc	39,728	.....
Total for colliery use	.....	39,728
		438,102
Stock on hand first of year	4,941	.....
" " " last of year	1,361	.....
Difference added to stock during year		3,580
Output of colliery for year	.....	434,522

*Annual Report of Minister of Mines, B.C., 1912.

Number of Hands Employed, Daily Wages Paid, etc.

Character of Labour	Underground		Above Ground		Total
	No. employed	Average daily wage	No. employed	Average daily wage	No. employed
		$		$	
Supervision and clerical assistance	15	.....	13	.....	28
Whites—Miners	262	3.30–7.00	.....	.....	262
Miners' helpers	24	2.86	.....	.....	24
Labourers	305	2.86–3.30	15	2.75	320
Mechanics and skilled labour	63	2.86–3.57	58	3.00–4.50	121
Boys	38	1.10–2.45	17	.50–1.65	55
Japanese	.....	.....	.....	.....	.....
Chinese	.....	.....	83	1.50–1.88	83
Indians (natives of B.C.)	.....	.....	.....	.....	.....
Totals	707	.....	186	.....	893

Mine worked 301 days during the year.

Coal Bunkers and Shipping Docks.—The coal bunkers are situated near the docks and have a capacity of 7,000 tons of lump and egg coal, 700 tons of nut coal, 300 tons of No. 1 pea coal, and 300 tons of No. 2 pea coal.

The shipping docks consist of two sets of double docks, or four single docks, and one gravity loading double dock. The single docks are equipped with compressed air shunting machines and have a ship-loading capacity of 400 tons per hour each. The double dock has a capacity of 300 tons per hour. The docks can accommodate vessels of not more than 30 ft. draught at any stage of the tide. Before loading, all coal is weighed on the general scales.

Northfield Mine

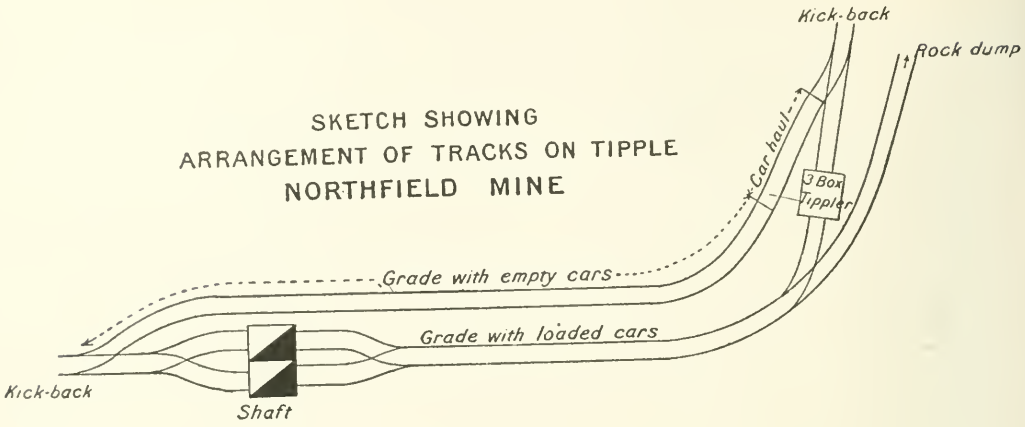
This mine is situated on Departure bay, about two miles north-west of No. 1 shaft. To facilitate the transportation of coal from the mine to the shipping docks a shaft, 60 ft. deep, was sunk near the sea-shore on a point between Exit channel and Departure bay.

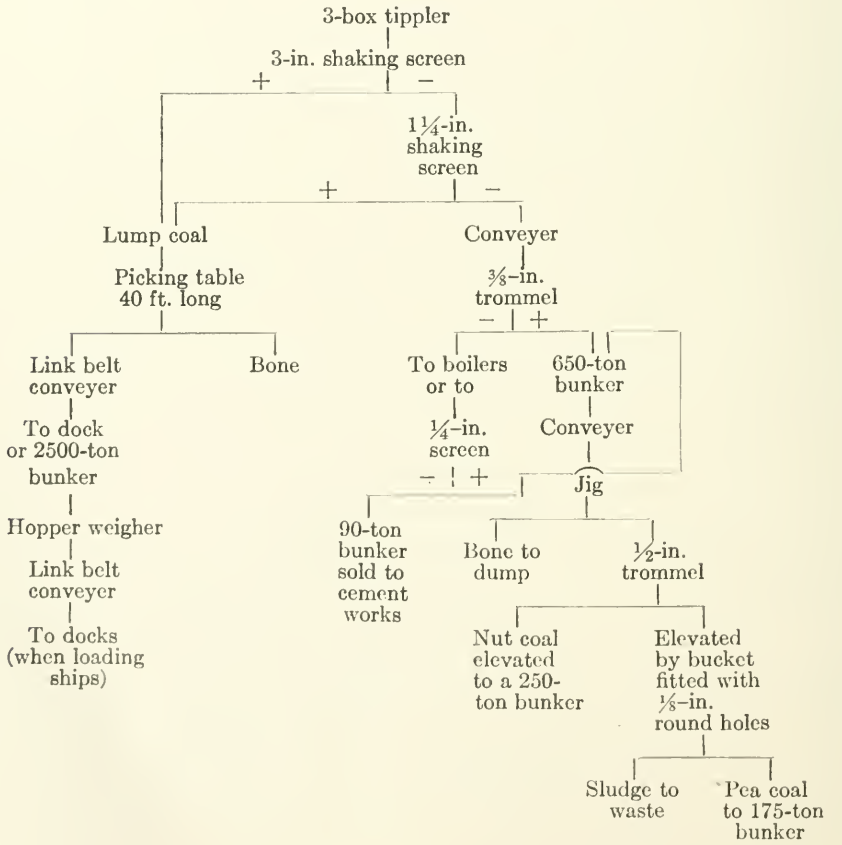
Method of Mining.—The workings are all on Newcastle seam and the coal is mined on the longwall system. It is of good quality, stands handling well, and is from 30 in. to 40 in. thick. The floor is mined to give the roads sufficient height. The roof is allowed to settle on timber cogs. From the bottom of the shaft, the main slope has been driven down the dip for about one mile. Six levels have been opened off the slope to the right and four to the left.

An endless-rope system of haulage, operated by an engine at the surface, is used on the main slope. A travelling road-way for the men has been driven from the surface parallel to the slope, and it and the main slope are well lighted by electric lamps.

In addition to the work done in this seam, connections have been made in several places with the upper or No. 1 Douglas, but very little mining has been done in the latter from this mine.

The following sheet shows the general arrangement of the tracks at the pit-head and the method used in sizing and washing the coal :


SKETCH SHOWING
ARRANGEMENT OF TRACKS ON TIPPLE
NORTHFIELD MINE
Kick-back
Rock dump
Car haul
3 Box Tippler
Grade with empty cars
Grade with loaded cars
Kick-back
Shaft


3-box tippler
3-in. shaking screen
+
−
1¼-in. shaking screen
+
−
Lump coal
Conveyer
Picking table 40 ft. long
⅜-in. trommel
− +
Link belt conveyer
Bone
To boilers or to
650-ton bunker
To dock or 2500-ton bunker
¼-in. screen
Conveyer
− + Jig
Hopper weigher
90-ton bunker sold to cement works
Bone to dump
½-in. trommel
Link belt conveyer
Nut coal elevated to a 250-ton bunker
Elevated by bucket fitted with ⅛-in. round holes
To docks (when loading ships)
Sludge to waste
Pea coal to 175-ton bunker

The following gives the approximate percentages of the different sizes of coal obtained and marketed:

Lump coal	70 to 72 per cent.
Nut	15 to 20 " "
Pea	15 " "
Sludge (wasted)	2 " "

The following are the official returns of the Northfield Colliery for 1912.*

NORTHFIELD COLLIERIES, 1912

Sales and Output for Year	Coal	
(Tons of 2,240 lbs.)	Tons	Tons
Sold for consumption in Canada	16,694	.....
" " export to United States	77,534	.....
" " " to other countries	19,397	.....
Total sales	.....	113,625
Used under colliery boilers	28,323	.....
Total for colliery use	.....	28,323
		141,948
Stocks on hand first of year	470	.....
" " " last of year	50	.....
Difference taken from stock during year	.....	420
Output of colliery for year	.....	141,528

Number of Hands Employed, Daily Wages Paid, etc.

Character of Labour	Underground		Above Ground		Totals
	No. employed	Average daily wage	No. employed	Average daily wage	No. employed
		$		$	
Supervision and clerical assistance	8	.....	8	.....	16
Whites—Miners	156	3.30–5.50	.....	.....	156
Miners' helpers	5	2.86	.....	.....	5
Labourers	141	2.86–3.30	6	2.75	147
Mechanics and skilled labour	16	2.86–3.57	20	3.00–4.00	36
Boys	14	1.10–2.20	6	1.00–2.25	20
Japanese	.....	.....	.....	.....	.....
Chinese	.....	.....	38	1.50–1.88	38
Indians	.....	.....	.....	.....	.....
Totals	340	.....	78	.....	418

Mine worked 297 days during the year.

*Annual Report of Minister of Mines, B.C., 1912.

Power Plant.—The power plant consists of :

Boilers.—Two 80-h.p. flue boilers.

Four 120-h.p. return tubular boilers.

Air Compressors.—One cross-compound air compressor ; steam cylinders, 20 in. and 36 in. by 30-in. stroke ; air cylinders 20 in. and 32 in. by 30-in. stroke.

One duplex air compressor ; cylinders 14 in. by 22-in. stroke.

One duplex air compressor ; cylinders 12 in. by 16-in. stroke.

Electric Machinery.—The electric plant consist of a 14 in. by 14 in. Robb-Armstrong engine belted to a 75-k.w. generator.

Three 16-h.p. electric hoists for use on the coal docks.

Haulage Engines.—The shaft hoist has a 4½-feet drum ; size of cylinders, 16 in. by 22-in. stroke.

The endless-rope system is operated by a 16 in. by 20-in. stroke steam engine.

Vancouver Nanaimo Coal Company

This mine is situated at East Wellington, about two miles distant from Nanaimo. A railway spur, two miles in length, connects with the Esquimalt and Nanaimo railway at Newcastle townsite and the shipping wharves on Exit channel.

The coal seam worked is locally known as the "Old Wellington," and has an average thickness of about 6 ft. Owing to the occurrence of "pinches" and "swells", it varies from a maximum thickness of 11 ft. to a minimum of 4 ft. The average dip is about 12° to the east. The levels and stalls are laid out with reference to the "cleat" of the coal.

The mine is opened up by a haulage slope driven from the surface to the dip. Its average inclination is 27°, and coal was first encountered at a distance of about 1,100 ft. on the slope, and 420 feet vertically, from the surface. There is also a counter slope which is used as a return air-way.

Method of Mining.—From the bottom of the slope two main levels are driven for a distance of 1,600 ft. with a bearing of N. 65° E. Pillars, 50 ft. x 120 ft. are left between the levels. The system of mining used is pillar-and-stall. The stalls are driven at an angle of 45° to the levels, and are 20 ft. wide and 120 ft. long The pillars are 60 ft. in width. A small section southeast of the bottom of the slope has been worked by the longwall method. The roof is a dark, brittle shale, and to get sufficient height for the mine cars, it is often necessary to brush 2 ft. from the roof. This rock is closely packed in the gob.

While, owing to the size of the pillars left and the systematic manner in which the mine is worked, the present extraction in advanee

Loading Scow by Belt-conveyer, Pacific Coast Coal Co., Boat Harbour, V.I.

Bunkers and Shipping Wharf, Pacific Coast Coal Co., Boat Harbour, V.I.
The photograph shows waste of slack coal at tidewater

work does not exceed 25 per cent, it will be possible to eventually recover almost all the pillar coal.

Very little gas has been found in the mine and open lights burning acetylene and oil are used.

At present the coal is mined by hand, but the company intend to install coal cutters in the near future.

In timbering 24 lineal feet are used per ton of coal mined.

Blasting Methods.—The blasting is done by battery and 30 per cent dynamite. The tamping material used is wet rock, dust and clay.

Mine Equipment —Fourteen horses are used for underground haulage The coal is hauled up the slope in trips of eight to ten cars of 1,600 lbs. capacity, by means of a second motion hoist, size of cylinders 10 in. diameter by 12 in stroke The cars are hauled to the landing and lowered on to the full track siding on the tipple. After passing over the weigh track they are dumped by a rotary tipple on to a long shaking screen, divided into sections and fitted with perforated plates. The first section has 1-in. perforations, then comes a blank plate for picking the coal, and next in order, 1-in. and 1½-in. perforated plates. The undersize from the first 1-in. screen is caught on a ½-in. screen, and the oversize from the latter is delivered into a pocket for re-screening. The undersize from the ½-in. screen drops into the slack coal bunker. The oversize from the 1-in. screens passes over a 1½-in. screen, the undersize goes to the nut coal bunker and the oversize to the lump coal bunker.

The coal to be re-screened is elevated to a ¼-in. and ⅝-in. trommel. All under ¼-in. is discarded as slack. The coal which passes through the ⅝-in. screen goes to the pea coal bunker and the oversize from the ⅝-in. screen is nut coal.

The tipple has a bunker capacity for 500 tons of lump coal, 100 tons of nut and 100 tons of pea coal. The mine has a capacity of 600 tons per day, but the actual average is about 300 tons. There are 70 men employed underground and 20 above ground.

The boiler plant consists of 2 x 65-h.p. return tubular boilers.

Ventilation—The ventilating fan is a 9-ft. Sheldon fan, direct driven by a 10 in. x 12 in. steam engine, delivering 30,000 cu. ft. of air per minute. The mine is ventilated by two currents of air, one split going to the rise and one to the dip.

Pacific Coast Coal Mines, Limited

This company is at present operating two mines, the Fiddick colliery at South Wellington and the Suquash colliery situated on the east coast of Vancouver island, near Malcolm island. As the Suquash colliery is, as yet but a small producer, and because of the

length of time which would have been necessary to make the visit, it was not examined.

Fiddick Colliery

This mine is situated on the Esquimalt and Nanaimo railway, three quarters of a mile from South Wellington station. The coal seam worked (locally known as Douglas) varies in thickness from 2 ft. to 28 ft. and has a dip of 1 in 8 to the northeast.

The mine is opened up by two slopes, No. 1, or Fiddick, and No. 2, or Richardson. As entrances to the slopes are very close together the coal is hoisted from both slopes by the same engine, and is screened on the same tipple. From No. 1 slope, three levels, Nos. 2, 3 and 4 have been turned to the east, and two levels, No. 2 and No. 3, have been turned to the west. Three levels, Nos. 4, 5 and 6 have been turned to the right from No. 2 slope.

Very little gas has been found in the mine and open and safety lamps are used. Wolf safety lamps are used exclusively in pillar work.

Method of Mining.—The system of mining is room-and-pillar. The rooms vary from 100 ft. to 300 ft. in length and from 18 ft. to 20 ft. in width. The pillar width is 50 ft. The proportion of coal extracted in advance work is about 33 per cent, but, upon withdrawing the pillars, nearly all the coal is recovered. The pillars are drawn by what might be called a longwall retreat method. The cover varies from 80 ft. to a maximum of 1,800 ft. The roof is dark shale and the coal breaks clean from the roof. The floor or pavement consists of shale and is rough and undulating.

Blasting Methods.—The blasting is done by means of battery and No. 4 and No. 6 electric detonators, the operation being under the supervision of shotfirers. The explosive used in coal is Monobel ; 30 per cent dynamite is used in rock work. The shooting is done during two regular hours per day. The tamping material used is clay, which is sent into the mine.

Horses are used for haulage on the main roads, which are lighted by electricity at 110 volts.

In timbering, about 7 lineal feet of props are used per ton of coal mined.

The mine has a capacity of 2,000 tons per day, but the actual average is about 800 tons. There are 325 men employed underground and 60 above ground. The mine is ventilated by a 9 x 12 Sheldon fan delivering about 85,000 cu. ft. of air per minute. The water-gauge is ¾-in.

Mine Equipment.—The coal is screened over 5-in. and 1¼-in. screens, and all that passes through the 1¼-in. screen is sent by railway car to the washery at Boat harbour, about $7\frac{1}{8}$ miles distant.

The slack coal (under 1¼-in.) is dumped into a 40-ton hopper and elevated to the Jeffrey-Robinson washer. The washed coal is sized in a revolving trommel fitted with twosections of $^{3}/_{16}$-in. and ¾-in. perforations. The oversize from the trommel is conveyed to the nut coal bunker. The undersize from the $^{3}/_{16}$-in. screen is slack coal, a portion of which is sold and the remainder, constituting about 15 per cent of the output, is wasted. The undersize from the ¾-in. screen is conveyed to the No. 1 pea coal bunker.

The lump and egg coal from the mine is also brought by rail and delivered into bunkers situated at Boat harbour, which have a storage-bin capacity for 3,000 tons lump, 200 tons nut, 200 tons of pea and 200 tons of slack. The coal is loaded into ships by means of a conveyer belt.

Power Plant.—The power plant at the mine consists of 3 return tubular boilers of 100 h.p. each ; one 60-k.w., a.c. generator with 25-h.p. exciter ; one 707 cu. ft. per minute capacity Norwalk air-compressor ; one 480 cu. ft. per minute capacity Rand air-compressor; one 300 cu. ft. per minute capacity Ingersoll air-compressor ; one double drum, geared friction hoisting engine of 200 h.p.

The mine is also equipped with the necessary machine shops, blacksmith shop and carpenter shop for doing ordinary mine-repair work.

Canadian Collieries (Dunsmuir), Limited

This company, during 1910, acquired all the holdings of the Wellington Collieries Company, Ltd. They operate the following mines :

Extension Collieries in the Cranberry district ;
Union Colliery in Comox district.

Extension Collieries

These collieries are situated at Extension, and are connected with the Esquimalt and Nanaimo railway and the shipping docks at Ladysmith by a standard gauge railway, eleven miles in length.

The Extension collieries comprise the following mines : No. 1, No. 2, No. 3 and No. 4. No. 1, No. 2 and No. 3 mines are connected with, and worked from, the main rock tunnel. No. 4 is a separate mine and is opened up by shaft.

No. 1 Mine

No. 1 Mine tunnel branches off the main rock tunnel at about 4,000 ft. from the tipple. It was originally worked by pillar-and-stall system, by which not more than one-third of the coal in the seam was extracted, the remainder being left as pillars. In some cases, where

the roof was bad, several feet of coal were left in the stalls in order to hold up the roof. In the higher levels more than half the pillars and top coal has since been extracted.

Nearly all the mining done at the present time is pillar-and-stall, and there is some extraction of pillars. The coal is hauled up the slope and out of the tunnel by electric locomotives.

No. 2 Mine

Coal was originally hoisted from this mine by means of a slope driven from the surface, but, since the completion of the main tunnel, it has been hauled out by electric locomotives.

The mine is now being worked from two slopes, No. 2 and the Diagonal. No. 2 slope goes down past the lower end of the main tunnel about one mile distant from the tipple, and continues for a distance of about 2,200 ft. to the bottom of the basin. The coal from this district is brought out of the main tunnel by means of a motor-road, which has been driven round the basin. The system of mining is pillar-and-stall.

Owing to the bad condition of the roof a high percentage of coal is generally left in the roof. At the present time, most of the work done is in extracting pillars.

The Diagonal slope is driven to the dip about 750 ft. east of the inner end of the main tunnel. The coal from this district is hauled up the slope to the main tunnel by electric hoist.

No. 3 Mine

This mine is a continuation of No. 4 West level from the main tunnel. From No. 4 North level, the old slope continues to the surface. In this district, the old pillars are being extracted. The slope continues down the dip and crosses the basin mentioned in the description of No. 2 mine. In this portion of the mine, pillar-and-stall work is carried on. The coal from the lower levels is brought to the main tunnel by means of a slant motor-road.

No. 4 Mine

This mine is situated on the mine railway about a mile and a half south of the Extension tunnel. The entrance is by a shaft, 8 ft. by 16 ft., and 290 ft. deep. It is a new mine and the development work is not very extensive as yet.

The seam, worked at these mines, is locally known as the Wellington and varies in thickness from 18 in. to 12 ft., with an average thickness of 5 ft. The dip varies from flat to vertical. The switches in the main tunnel are lighted by electricity at 250 volts. The main

tunnel is 12 ft. by 6 ft., is equipped with double tracks, and electric locomotive haulage is used exclusively in it.

Method of Mining.—In the pillar-and-stall work, the sizes of the pillars and stalls vary, depending on the condition of the roof. In dirty ground, the rooms vary in width from 14 ft. to 16 ft. In No. 1 mine the rooms are generally 60 yds. long and 10 yds. wide ; the pillars are 20 yds. wide and crosscuts 4 yds. wide are driven through the pillars 20 yds. apart.

From the foregoing it can be seen that about two-thirds of the coal is left as pillars. To recover it, where the roof is good, the procedure is as follows : a skip, 15 ft. wide, is first taken off one side of a row of pillars ; a room 12 ft. wide is driven through the centre of the pillar, which is then removed by slicing back across it. Cogs, 4 ft. by 4 ft., or 4 ft. by 8 ft. (depending upon the condition of the roof), are put in 5 ft. apart, and in rows spaced 10 ft. apart. In recovering the old pillars, an extraction of 50 per cent is obtained, and, in the case of new pillars, an extraction of 90 per cent. The explosives used for blasting the coal are 30 per cent dynamite and Monobel. Forty per cent dynamite is used for brushing the roof or floor.

In timbering, about 6 lineal feet of props are used per ton of coal mined. The roof over the coal is shale and conglomerate and the floor is hard sandstone. The cover over the workings varies from nil to 450 ft. The mines have a capacity of 1,400 tons per shift but the actual average is about 1,100 tons. Electric locomotives haul the coal out of the mine in cars of a capacity of 1,600 pounds each. From the landing, they are pushed to the tipple by means of a steam actuated piston.

The coal is screened over two sets of shaking screens, in parallel, 5 ft. wide and 18 ft. long. The top screen is fitted with 2½-in. perforated plates and the lower with 1½-in. perforations. The oversize from each is picked on separate picking tables, 3½-ft. wide by 67 ft. long, which discharge the coal into 23-ton railway cars. The undersize, amounting to about 40 per cent of the output, is loaded into railway cars and sent to the washery.

Mine Power Plant.—The boiler plant consists of four 30.8-h.p. return tubular boilers and one 45.5-h.p. marine type boiler.

The electric plant consists of two 17 in. by 14 in. steam engines directly connected to two 112½-k.w. direct current generators. The electric current is generated at 280 volts, and is used for motor haulage and lighting purposes.

Washery, Bunkers and Shipping Docks.—The washery, bunkers and shipping docks are situated on tide-water at Ladysmith. The bunkers

have a capacity of 6,000 tons of lump coal, 1,000 tons of nut and 50 tons of pea. The docks have a loading capacity of 5,000 tons in nine hours and two large and two small boats can be loaded at the same time.

The screenings are dumped into a bin from which the coal is fed to two Robinson washers in parallel, thence it is sluiced over a trough screen fitted with $^3/_8$-in. square holes ; the oversize is distributed by launders to six jigs. The product from the jigs is sized in a tapered revolving copper screen fitted with $^1/_8$-in. openings ; the undersize from this screen is then screened in a similar screen fitted with $^1/_{16}$-in. punched holes. The oversize from the two screens is mixed and elevated to the pea coal bin. The coal and sludge which passes through the $^1/_{16}$-in. screen is wasted. The following gives the percentages of the different sizes obtained :

Nut	51.57	per cent.	to	53.04	per cent.		
Pea	13.57	"	"	13.84	"	"	
Slack, Bone	33.12	"	"	34.86	"	"	(wasted)

The washery is driven by a Pelton wheel operating under a head of 186 ft. and developing 28 h.p. A second Pelton wheel is used to generate power for lighting purposes. The water from the two wheels is delivered to a tank and used for coal-washing.

Union Colleries

These mines are situated 4 miles west of Comox harbour, and 12 miles distant, by rail, from Union bay. The seams outcrop on Coal creek about one mile west of the town of Cumberland, and the western limit of the outcrop extends parallel to the trap ridges to Puntledge lake, crosses the eastern end of the lake and runs parallel to the Puntledge river for about a mile and a half. It then runs in a north-westerly direction and crosses Browns river about three and a half miles from Puntledge lake.

The strike of the seams generally runs parallel to the trap ridges which border the field. The dip is to the east and varies from nearly vertical at some of the contacts, to nearly flat a short distance away from the edge of the field, but, in general, it varies from 5° to 10°. There are two workable seams within this area, separated by about 350 ft. of strata. No. 1 seam is 6 ft. thick and contains from 3½ ft. to 4 ft. of clean coal.

The following are two sections which were taken in 13th Level stall and 17th Level stall in No. 4 mine:

	13th Level	17th Level
Fire clay	2 ft. 0 in.	2 ft. 7 in.
Top coal	2 " 6 "	2 " 1 "
Parting	0 " 10 "	0 " 10 "
Bottom coal	1 " 6 "	1 " 2 "
	6 ft. 10 in.	6 ft. 8 in.
Total coal	4 ft.	3 ft. 3 in.

The great number of faults, rolls and horsebacks in this area makes the successful mining of coal most difficult. The faults generally make a small angle with the strike of the strata, and vary from rolls and horsebacks to normal and overthrust faults. The downthrow varies from a few inches in some cases to a maximum of over 300 ft., *e.g.*, the "Baynes Sound" fault.

Overlying the main seam there is a seam of fire clay which varies in thickness from a few inches to three feet. It is of good quality and is used in limited quantities by the British Columbia Pottery Company, but, if a large market could be obtained, it would prevent the wasting of such a valuable mineral. At present, it is either left in the roof or mixed with dirt and rock and stored in the gob (underground). The fire-clay roof is also dangerous, as it is full of slips which cause the roof to fall in the rooms without cracking and thus, without warning to the miners. Three-fifths of the accidents in 1910 were due to this cause.

The following mines in the field are operated by the Company :

No. 4 Tunnel
No. 5 Shaft
No. 6 Shaft
No. 7 Tunnel

No. 4 Tunnel

This mine is situated on the east shore of Puntledge lake, one and one-half mile distant by rail from Cumberland

The strike of the measures is about N. 70° W. (magnetic); the average dip is about 9½°. The thickness of the coal mined varies from 3¼ ft. to 4 ft. The mine is opened up by two slopes, No. 1 and No. 2. No. 1 slope is about 1½ miles in length, and is driven on an angle with the pitch, the bearing being about N. 25° W. No. 2 slope branches off No. 1 slope 165 ft. from the portal and is driven on a bearing N. 20° E. for a distance of about 1½ miles. The maximum amount of cover over the workings is 1,000 ft. Main and counter levels have been opened off the slopes every 400 feet.

Method of Mining.—The system of mining is pillar-and-stall. The levels are driven to the boundary, and, as soon as the stalls are

driven, the pillars are removed. The stalls, 300 ft. long and 36 ft. wide, are driven up the pitch from the level to the counter above. The centre of the stall forms a gob and tracks are laid on each side. Jigs or balances are used to lower the coal to the level and to hoist up the empty car. The room pillars are 66 ft. wide. The pillars left between level and counter are 100 ft. by 120 ft. long. Crosscuts, for ventilation, are driven through the room pillars 120 ft. above the level.

Timbering.—In drawing pillars, a skip 15 ft. to 20 ft. wide is first taken off one side of the pillar ; the pillar is then removed by slicing back beginning at the top. Cogs, 5 ft. by 5 ft. are put in to support the roof, but, in air courses, they are placed 3 ft. apart. It has been found that, if timber is put in instead of cogs, the pressure exerted by a squeeze crushes the top coal and throws all the weight on the timbers, thus crushing them in turn.

In timbering, 4 lineal feet of props and stringers and 5 lineal feet of cog material are used per ton of coal mined.

The proportion of coal taken out in advance work is about 35 per cent. On account of the overhanging rash and fire clay falling on the coal, from 5 per cent to 7 per cent of the coal is thrown into the gob. About 90 per cent of the pillars is recovered.

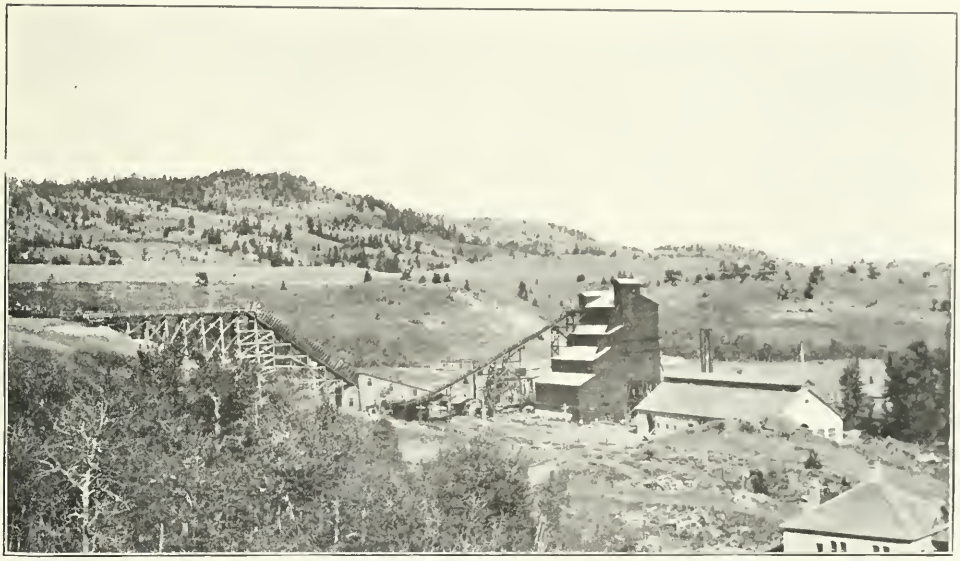
Ventilation.—The mine is ventilated by drawing the air down the main slope and thence along the levels and back through the rooms and counter levels. In this way, it is made to start at the bottom workings and gradually rise through the working places towards the fan on the surface. There are four air returns and two intakes for each slope. Two direct driven Guibal fans, 30 ft. by 11 ft. and a small belt driven Murphy fan, 8 ft. by 4½ ft., delivering about 120,000 cu. ft. of air per minute are used.

Gas has been found in some of the pillar workings, but no shooting is permitted in these places and Wolf safety lamps only are used. Open lamps are used in some sections of the mine. The main roads are lighted by electricity at 250 volts.

Haulage.—The haulage on No. 1 and No. 2 slopes is by main and tail rope. Horses are used on the levels. The mine has a capacity of 1,200 tons per day, but the actual output is about 1,000 tons. There are 375 men employed underground and 95 above ground.

The coal is screened over a bar screen with 1-in. spaces. About 65 per cent passes over the screen. The screenings are sent to the washery.

Power Plant.—The boiler plant consists of :—Three 108-h.p. boilers which are used to furnish steam for the following engines : One



Washery and Power Plant, Leitch Collieries, Passburg, Alta.

Coal Wharf, Canadian Collieries, Ladysmith, B.C.

16 in. by 16 in., steam engine belted to a 75-k.w. direct current generator producing power for the mine pumps ; one, 13 in. by 13 in. steam engine belted to a 50-k.w. direct current generator producing power for mine use at 275 volts ; and one, 15 in. by 15 in. steam engine belted to a 50-k.w. direct current generator producing power for mine use. Three boilers are used to generate power for the main hoist. Two 62 h.p. flue boilers and four 30.8-h.p. boilers are used to generate power for fan engines.

Eight electric triplex and two centrifugal pumps are used to pump 450 gals. of water per minute from the mine. The pumping is done in two stages.

The company have installed a 9,400 h.p. hydro-electric plant at the Puntledge river. This plant furnishes power for all the mines, thus superseding the steam installations, and will save nearly 24 per cent of the output.

No. 5 Mine

This mine is situated about one and one-quarter mile east of No. 4 Mine and about one-half mile from Cumberland. Two seams have been opened up by a vertical shaft 610 ft. in depth. The upper seam only, situated 280 ft. from the surface, is now being worked. It varies in thickness from a few inches to seven feet, but the average is about 3½ ft. The coal is hard and of good quality, but is split up by several partings. The following are two sections, taken in stalls, east of North incline and No. 2 level, respectively :

Top coal.....12 in.	.....13 in.
Shale.....14 "	..... 9 "
Coal.....12 "	.....12 "
Rash..... 8 "	Shale..... 4 "
Coal.....18 "	.....19 "
.....	Rash..... 8 "
.....	Coal.....18 "
Total coal.....2 ft. 6 in.	Total coal 5 ft. 2 in.

The seam has a dip of from 6° to 7°, and is badly dislocated by faults. The roof is hard sandy shale.

This mine is connected with No. 6 Mine by a good travelling-road, fitted with double doors, allowing separate intake and return air-ways It is worked by a main level driven off the shaft with inclines driven up the pitch from the level. The main level is 6½ ft. by 15 ft. wide and the counter level 5½ ft by 14 ft. wide.

Method of Mining.—The system of mining is pillar-and-stall. The stalls are 36 ft. wide and vary in length up to 300 ft. The pillars are 36 ft. wide. The proportion of coal taken in advance work is about

50 per cent. Owing to impurities, about 7 per cent is thrown into the "gob." The pillars have not yet been recovered. In timbering, 2 lineal feet of props are used per ton of coal mined. The mine is ventilated by a 5 ft. by 15 ft. direct driven Guibal fan running at 110 r.p.m. and delivering 40,000 cu. ft. of air per minute.

Blasting Methods.—No. 5 detonators and giant powder are used for blasting the coal.

The mine has a capacity of 600 tons per day, but the actual average is about 460 tons. There are 135 men employed underground and 35 above ground.

The coal is screened over a 1½-in. bar screen, 12 ft. long, and shipped by railway to the washery and coal docks situated at Union bay.

The power plant at the mine consists of six 35-h.p. boilers and a Corliss valve hoisting engine, size of cylinders 30 in. x 60 in.

No. 6 Mine

This mine, situated within the town of Cumberland, is opened up by an 8 ft. by 18 ft. vertical shaft, 242 ft. in depth. The seam is the same as that worked at No. 5, and the statements with reference to No. 5 Mine apply to it here also. The system of mining is pillar-and-stall. The stalls are 33 ft. wide and vary in length up to 300 ft. The pillars are 45 ft. wide. In timbering, 2½ lineal feet of timber are used per ton of coal mined. The mine has a capacity of 500 tons per day but the actual average is about 360 tons. There are 125 men employed underground and 38 above ground. The coal is screened over a 1¼-in. bar screen, 14 ft. long, about 38 per cent of the output passing through it. The coal is shipped by railway to the docks and washery at Union bay.

The power plant consists of four 35-h.p. boilers ; hoisting engine for shaft, size of cylinders, 18 in. by 30 in.; two small air compressors ; and a fan engine direct connected to a 5 ft. by 15 ft. steel Guibal fan.

No. 7 Mine

This mine is situated two miles in a direct line from No. 4 Mine, and about five miles from Cumberland. The slope is down a distance of 5,600 ft., and in good coal, of a very hard nature. It is well adapted for a longwall system ; the coal averages 3½ ft. in thickness, with rock in the centre.

Washery.—The lump coal is brought from the mine in 20-ton railway cars and is either dumped into a 3,000-ton lump coal bunker or into a conveyer and loaded into vessels. The facilities permit—neglecting trimming—loading from 5,000 tons to 6,000 tons in 24 hours. The maximum quantity of coal that has been loaded into a ship in 10 hours is 2,700 tons. Even at low tide the wharf can accommodate a vessel 550 ft. in length and of 30-feet draught.

The screenings are brought from the mine in 20-ton railway cars and dumped into a 140-ton bunker situated at the washery. The coal is then elevated to the top of the washery and fed to four Robinson washers, the overflow passing over a $^3/_8$-in. square screen. The oversize from this screen is conveyed to a 120-ton nut bunker ; the undersize is sent to a V settling tank, the overflow from which goes to waste. The fine coal from the tank is next distributed by launders to ten jigs. The washed coal and overflow from the jigs is settled in a 'Spitz' tank and sized over a $^1/_8$-in. and $^1/_{16}$-in. trommel. The sized products from the two trommels are united and conveyed to a 160-ton pea coal bunker. All coal under $^1/_{16}$-in. is wasted.

The following are the official returns from the Union Collieries for the year 1912 :

UNION COLLIERIES, 1912

Sales and Output for Year	Coal		Coke	
(Tons of 2,240 lbs.)	Tons	Tons	Tons	Tons
Sold for consumption in Canada	269,020	.....	4,266	.....
" " export to United States	57,677	.....	.....	.....
" " " to other countries	15,311	.....	.....	.....
				.....
Total sales	.....	342,008	.....	4,266
Used under colliery boilers	40,256	.....	.....	.....
Lost in washing	114,246	.....	.....	.....
Total for colliery use	.....	154,502	.....	.....
Stocks on hand first of year	23,488	.....	6,636	.....
" " " last of year	2,781	.....	2,370	.....
Difference added to stock during year	.....	20,707	.....	4,266
Output of collieries for year	.....	475,803	.....	Nil

From the foregoing it can be seen that 114,246 tons—24 per cent of the output—has been wasted. This loss does not represent clean coal because it has been found that 9 per cent of the original screenings passes through a $^1/_{16}$-in. screen and assays 40 per cent ash ; also, 27 per cent of original screenings, containing the same high ash content, passes through a $^1/_8$-in. screen.

APPENDIX II

BY-PRODUCT COKE OVENS OF THE ALGOMA STEEL COMPANY, SAULT STE. MARIE, ONT.*

The coal used for making blast furnace coke must be :

1. A good coking coal.
2. Low in sulphur.
3. Fairly low in ash.

The West Virginia and Pennsylvania are the only coals in the middle and eastern states possessing these requisites ; consequently these coals are used in all the great iron manufacturing centres east of the Mississippi valley.

The Algoma Steel Company imports coal from two localities, and mixes them prior to coking. They use :

1. Cannelton (Kanawha coal, northern West Virginia), a coal containing a high percentage of volatile, combustible constituents and analysing, proximately : Volatile, 34 per cent.; ash, 6-8 per cent.

2. Pocahontas coal (southern West Virginia), low in volatile, combustible constituents, and analysing, proximately : Volatile, 19 per cent ; ash, 6½ per cent.

The coal is shipped by rail to the Lake Erie ports—Toledo or Sandusky, Ohio ; thence by water to the Company's docks at Sault Ste. Marie, Ont.

Coal-handling Machinery

The coal is unloaded from the vessels by means of twe olectrically operated steel towers with a capacity of 180 tons per hour each ; 9500 tons have been unloaded from vessels in 34 hours working time. The labour employed on each tower consists of one man to operate the hoist.

Description of Tower

The coal is hoisted from the vessel by means of a 3½-ton bucket and is then dumped into an 80-ton hopper situated on the tower. It is discharged from the hopper into an electrically operated 20-ton car, and is then either conveyed, by means of this car, direct to the hopper that supplies the Bradford breaker, thence to the coke ovens, or carried to the stock pile, where it can be dumped on either side of the track by means of the air lift door, depending, of course, on whether it is Pocahontas or Cannelton coal, the two varieties of coal being kept separate on the stock pile. The 6½-ton bucket suspended

* An examination was made of this plant through the courtesy of Mr. Ernst, the manager. Thanks are also due Mr. Davies, superintendent of the coke oven plant, for much of the information contained herein.

from the travelling bridge distributes the coal on the pile. About 1560 tons of coal are used per day to supply the coke ovens.

The coal is loaded from the stock pile, by means of the bucket and bridge mentioned above, and is dumped into a 20-ton electrically driven car which carries the coal to a hopper. From the hopper the coal is then elevated by means of an endless belt to the Bradford breaker. The Bradford breaker consists of a revolving horizontal steel screen, in which the perforations are about 1½ in. in diameter, and which is fitted with radial shelves. These shelves pick up the coal and drop it, crushing it by its own weight. Short deflecting plates cause the oversize to discharge into a 30-ton railway car. The undersize goes to a mixing bin.

The two varieties of coal are kept separate and stored in separate bins of a capacity of 100 tons each. The coal from the two bins is mixed together in the proper proportion, namely, 60 per cent Cannelton and 40 per cent Pocahontas coal, by means of adjustable feed hoppers, situated on the outlets of the bins, and by revolving belts.

From the mixers, the coal passes through two magnetic separators which remove pick-points, or other iron or steel ingredients. It then goes to two Williams disintegraters.

In most by-product plants 75 per cent of the coal must pass through a $^1/_8$ in. screen. The practice at this plant is to mix the coal so as to give 60 per cent Cannelton and 40 per cent Pocahontas coal.

The structure of coke is affected by three factors, viz :

1. The chemical composition of the coal itself.
2. The rapidity of burning.
3. The fineness of the coal charged into the ovens.

In this plant, all these factors can be adjusted by means of the variable feed, the crushing of the coal, and the firing of the ovens. In general, it may be said that very low volatile coal tends to merely sinter together if heated very slowly ; on the other hand, if heated rapidly, fusion is completed.

Cross-Checking.—The degree of the fineness of grinding primarily determines the size of the slate or bone which may be in the coal. After coking, the slate or bone, which keeps its size and shape, causes cross checking ; hence, if the grinding is coarse, a friable coke is obtained. Notwithstanding this cross checking, however, the internal structure of the coke is the same, whether the grinding be coarse or fine.

From the crusher, the coal is carried by endless belt to a 2,000-ton storage bin, which is situated over the centre of the two batteries of ovens. The bin is fitted with three sets, of 4 hoppers each, for loading

the "lorry car." This car has the same capacity as one oven and discharges into the oven through 4 hoppers. Each oven has 4 charging holes.

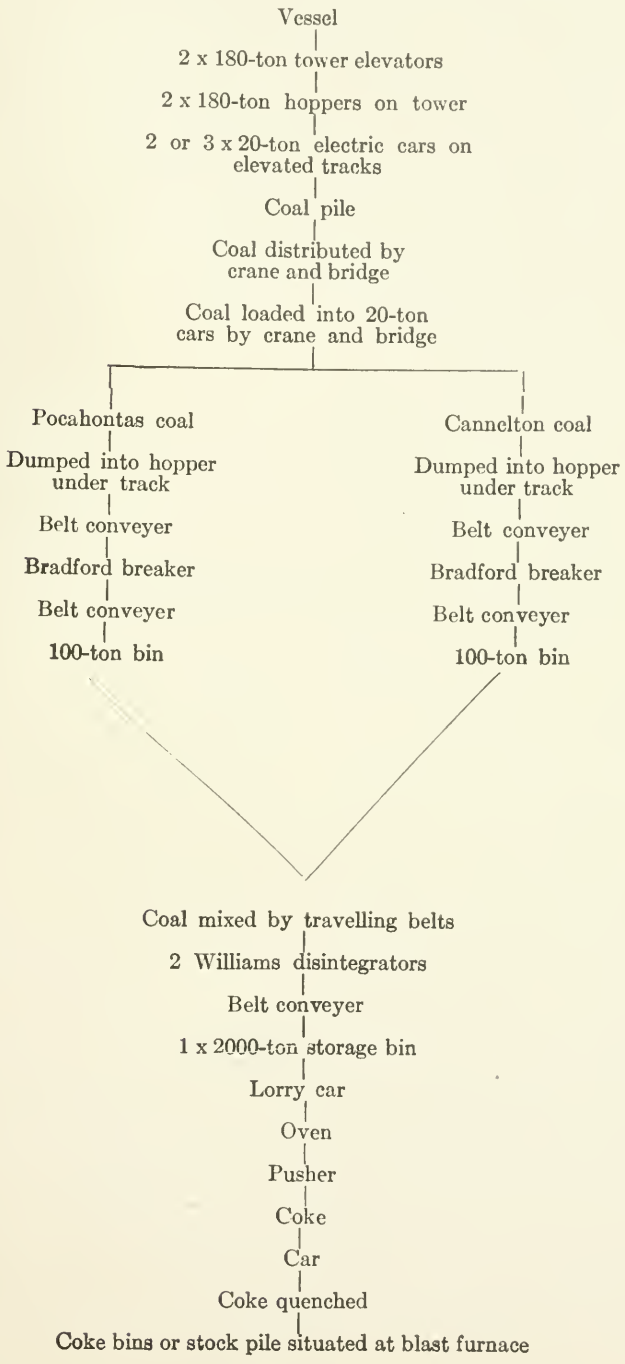
Ovens

The ovens, 110 in number, consist of two batteries of 55 ovens each. They are 21 in. wide, tapering to 17 in. at the ram end, 9 ft. high, and 38 ft. in length. The capacity of an oven is about 12.9 tons of coal or 9.7 tons of blast furnace coke, and the time required for coking is 21 hours. The coke is discharged from the oven into steel cars by means of an electrically operated "pusher." It is then quenched in the car and is hauled by a steam locomotive to the storage bins, which are situated at the blast furnaces.

The following diagram shows coal and coke flow sheet.

By-product Coke Ovens, Algoma Steel Co., Sault Ste. Marie, Ont.

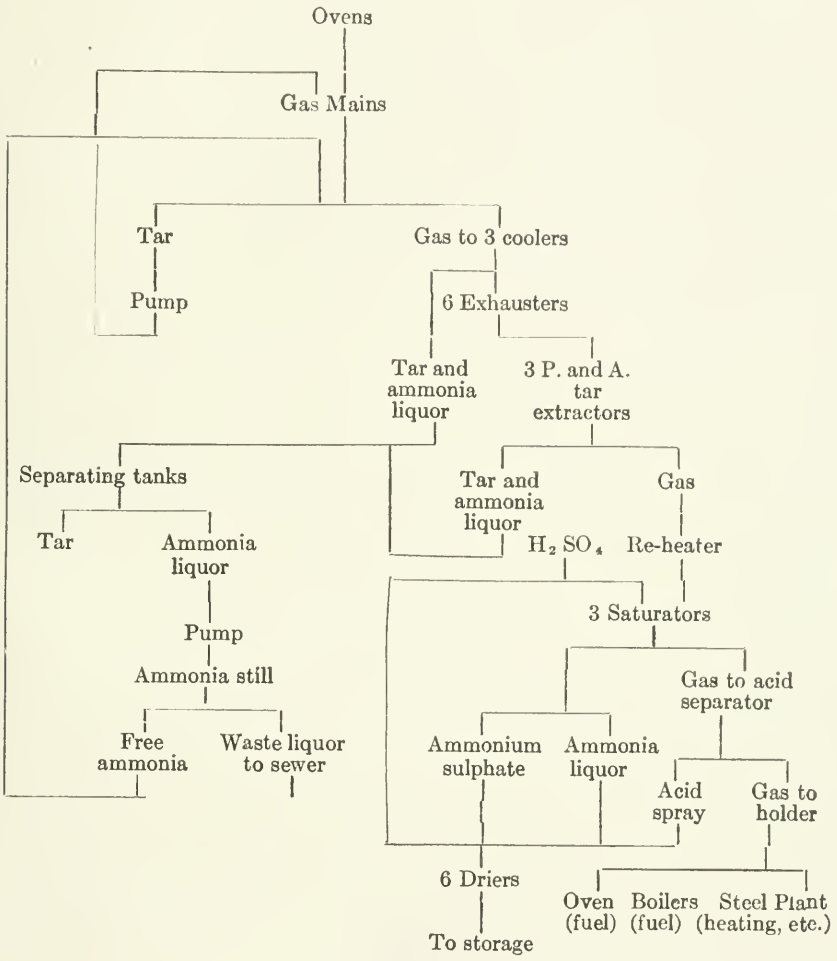
Flow Sheet for Coal and Coke



Regenerative System of Heating Ovens.—After the gas has been deprived of its by-products, it is fed from the distributing main into the gas-distributing channel. This channel is formed of fire brick and is situated beneath the walls of each oven. The gas passes from this channel through orifices, which are each fitted with a gas nozzle, and burns in thirteen vertical flues, built in the wall between a pair of ovens. The gas, after burning in the first thirteen vertical flues, passes into a horizontal flue, down through the remaining thirteen vertical flues in the same wall, thence through a 'checkerwork' or regenerator under the oven chamber, to the main flue, and thence to the stack. The gas and air-supply valves for heating alternate halves of the oven walls are situated at both ends of each wall. These are opened and closed simultaneously by a link. The operation consists in reversing these valves every 30 minutes, so that the gas burns alternately from each end of the oven, and the heated air for combustion is drawn from alternate regenerators. The gases from the distillation of the coal is drawn from each oven through a stand-pipe, passed to the by-product plant, where the necessary suction is furnished by three exhausters.

The following diagram shows the gas flow sheet :

GAS FLOW SHEET



BY-PRODUCT PLANT

The gas main, which leads from the ovens to the by-product plant, is set on an incline, so that any tar that separates from the gas will flow out of a pipe, which leads to separating tanks. From the stand-pipe, the gas passes through three water-coolers into the exhauster, and from there into the tar extractor. The gas is cooled to a temperature of about 25° C. in the cooler, and, at this temperature, the tar is easily removed by the tar extractor. The gas is then heated to a temperature of about 50° C. in a re-heater, and is passed through a sulphuric acid bath in the saturator, which removes the ammonia.

The spray is removed from the gas in the acid separator, and the gas is collected in a gas holder.

The tar and ammonia liquor, which is collected from the coolers and tar extractors, is separated in the separating tanks. The tar is stored in tanks. The ammonia distilled, passes into the gas and is carried to the saturator, where ammonium sulphate is recovered. The tar is sold to the Dominion Tar and Chemical Company, Sault Ste. Marie, for refining. The pitch is sold to the Bankhead Mines, and, as stated on page 122, is used as a binder in the manufacture of briquettes. The ammonium sulphate is sold by the American Coal Products Company of New York.

The surplus gas from the ovens amounts to about 50 per cent of the total gas contained in the coal. A portion is burned under boilers and generates from 600 to 900 h.p. The remainder, amounting to about 4,000 cu. ft. per ton of coal coked, is used in the company's steel plant for re-heating blooms and billets, heating molten pig-iron mixer at Bessemer plant, etc. There is no waste of gas when the mill is in operation. The percentage recovery of coke (including breeze) is about 84 per cent.

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