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MINES BRANCH

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Gas Producer Trials with Alberta Coals

[*Supplementing Report No. 331*]

BY

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PREFACE

In 1913, gas producer tests, on a large scale, were conducted at the Fuel Testing Station, Ottawa, for the purpose of determining the value of various Canadian coals for steam raising; and for the production of power gas when burned in gas producers of a by-product recovery or non by-product recovery type. The first part of this investigation was completed in 1914, and a report entitled: "Results of Investigation of Six Lignite Samples obtained from the Province of Alberta," was published in 1915. The investigation as to the value of the various coals tested for steam raising, was completed in 1918, and a report giving the results, entitled: "Results of Forty-one Steaming Tests conducted at the Fuel Testing Station, Ottawa," was published in 1920. The following report contains the results of the tests conducted with the same class of fuels, in the double-zone Westinghouse Gas Producer.

Inasmuch as certain of the western lignites in their natural state, that is, as they are mined, are not adapted for steam raising when burned in the conventional combustion chamber of the steam boiler, it was considered that such lignites might prove to be excellent fuels for the production of power gas when burned in a suitable gas producer. The value of any fuel for this purpose is greatly enhanced when the nitrogen therein is especially high, since the nitrogen content can be efficiently recovered in the form of ammonium sulphate when the fuel is burned in a by-product recovery producer of the Mond type. These tests were, however, conducted in a Westinghouse, double-zone, suction gas producer. This type of producer was selected, because it is designed to do away with auxiliary tar cleaning apparatus. The upper portion of the producer is down-draught, while the lower portion is up-draught, hence the gas from these two portions of the producer is mixed at the common off-take. The tarry matter which is distilled in the upper zone, where the fresh coal is charged, is drawn down through the deep bed of hot carbon, until it reaches the off-take. In its passage through the hot carbon, reactions take place between the hot carbon of the fuel, and the hydro-carbons in the tarry matter, with the result that the heavy hydro-carbons are broken up, or cracked. The lower zone of the producer is fed with the coke or carbonized material resulting from the distilling of the volatile matter in the upper zone. This producer—as the tabulated results show—is not especially suited for all types of fuel; but certain of the lignites behaved admirably when burned in it, some requiring scarcely any attention, such as poking, while the gas produced was of fairly uniform composition.

The preparation of this report for the press was delayed on account of work which was given prior attention during the war; and to the resignation of several members of the staff of the Division of Fuels and Fuel Testing. This report is one of a series which will be published as the investigation proceeds.

B. F. HAANEL,
Chief Engineer,
Division of Fuels and Fuel Testing.

July 7, 1921.

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RESULTS OF GAS PRODUCER TRIALS WITH ALBERTA COALS

INTRODUCTORY

Report No. 331, published by the Mines Branch, contains the results of several trials carried out with six samples of Alberta coals, to determine their value for generating producer gas and for steam raising. The present report contains the results of trials conducted with additional samples of coal received from Alberta, in the double-zone Westinghouse gas producer. Inasmuch as a description of this producer, its principles of operation, and the method of carrying out the trials appear in report No. 331, they will not be repeated here in full, and only a few of the essential features of operation will be referred to.

The Westinghouse double-zone suction producer, was designed to give a tar-free gas from bituminous coals. The fuel is fed through an opening in the top, and the ash is withdrawn through a water seal at the bottom. The fuel burns in two currents of air; one current enters through the top of the producer, and the other through a tuyere situated at the bottom. The gas leaves through openings provided in a cast iron water container, known as the vaporizer, which surrounds the central portion of the fuel bed, then passes through a scrubber, and receiver, to a rotary exhauster, which delivers it under pressure to any point desired.

METHOD OF INTRODUCING AND MEASURING STEAM AND AIR SUPPLY TO THE GAS PRODUCER

To operate a gas producer successfully, it is necessary to supplement the air supply with steam, which reduces the temperature in the producer, and improves its efficiency. Too much or too little steam decreases the efficiency. Further, the quality of the gas produced varies with the relative proportions of air to each zone of combustion.

The manufacturers of the producer provided means for mixing steam with the air blast, but did not provide means for measuring either the steam or air supply. To remedy this, new apparatus has since been designed and constructed, which makes it possible to measure both the air and steam supply.

Fig. 1 shows this apparatus attached to the producer. The air supply to each zone of the producer is measured by drawing it through a circular orifice in a thin plate fastened to the end of a cylinder, and observing the difference of pressure between the inside and outside of the cylinder, or air box. The air box for the upper zone is shown at A on the right hand side of the producer. The air leaves the measuring box by a horizontal pipe, and meets, at F, a supply of steam which comes through the vertical pipe from the vaporizer D, in which it is generated under a pressure of about one inch of water. At F, therefore, the air is heated and saturated by the steam to a temperature which may be regulated by opening or closing the valve between F and D. From F, the steam and air pass upwards through

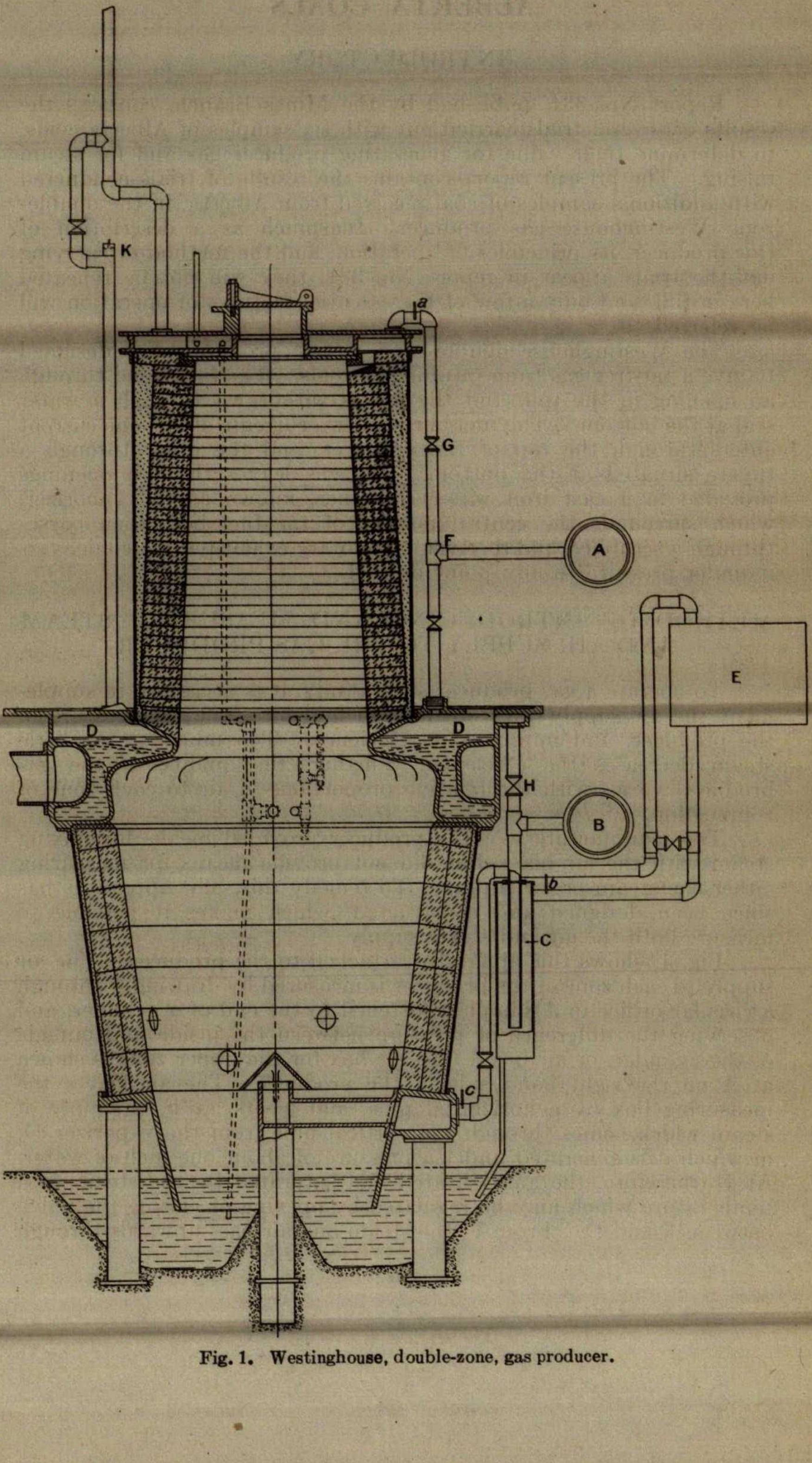

Fig. 1. Westinghouse, double-zone, gas producer.

the valve G, which controls the supply, past the thermometer a, through the cover and to the top of the fuel bed. The relative quantities of air and steam present may be calculated from the partial pressure of the steam corresponding to the saturation temperature shown by a, and the total pressure of the air and steam. Since the rate of air supply is already known from the air measuring boxes, the steam supply may be calculated by multiplying the air supply by the ratio of steam to air.

The air measuring box for the lower zone is shown at B. After leaving this box, the air is heated and saturated by steam which passes from the vaporizer down a vertical pipe, in which there is a regulating valve H. The saturated air passes through the condensed steam separator C, past the thermometer b, to a preheater E, then to the tuyere, through which it passes to the fuel bed. The preheater is heated with producer gas, and its function is to prevent the steam in the air blast condensing on its way to the producer. The temperature of the air blast entering the producer is shown by the thermometer c.

It is important that the steam in the vaporizer be kept under a slight pressure, since, if it is allowed to fall below atmospheric pressure, air may be drawn into the producer down the atmospheric pipe, and through the vaporizer to the producer. To prevent this, the valve on the atmospheric pipe is regulated so that steam is constantly blowing out, past the relief valve K.

The addition of this apparatus has proved a valuable aid in operating the producer and, as well, has given much valuable information, which is reported in the results of the trials.

OBJECT OF TRIALS

The aim of the trials was, as before, to ascertain the suitability of the various fuels for giving a clean combustible gas when burned in this producer. Unfortunately, it is not possible to express the value of the fuels for this purpose by even a few figures. But once it is shown that the fuel may be relied upon to produce a gas of a fairly good calorific value, continuously, without requiring undue poking in the producer, the outstanding figure to be looked for in the results is that showing the efficiency. The efficiency given here, is taken as the ratio of the calorific value of the total gas produced during a trial, to the calorific value of the coal charged. This figure would give the true efficiency of operation, if the fuel contents of the producer were the same at the end as at the beginning of a trial. But it is impossible either to ensure that the fuel contents are the same or to estimate the charge. In some trials the fuel contents have been so depleted that the carbon leaving as gas was greater than that charged with the coal, regardless of the fact that carbon also is removed from the base of the producer with unburnt fuel. An analysis of the refuse removed from the water seal does not give a true indication of the degree to which combustion has proceeded in the producer, since the refuse represents, even when removed at the end of a trial, that which has passed the combustion zone only in the initial stages, or previous to the actual commencement of the trial. It would only be possible to eliminate this error by operating the producer for a period far longer than the quantity of fuel available for a test would permit.

DETERMINATION OF TRUE EFFICIENCIES

It will be readily appreciated that the true efficiency of a producer of this type can be accurately determined only when the producer is operated continuously for a long enough period to ensure that the refuse removed from the water seal is what has resulted from the consumption of the fuel burned during the test. Even in commercial practice, such efficiency is most difficult if not impossible to determine when a badly clinkering fuel is burned, since the successful operation of the producer may be so seriously disturbed through the caking of the coal that it will be necessary, at times, to empty it either wholly or partially of its contents, and start anew.

RECORD OF SAMPLES TESTED

The following is a list of the companies operating the mines from which the coal samples were received. It includes those from which the samples came that were previously tested and reported in Report No. 331. The latter are marked with an asterisk.

From West Central Alberta and Edmonton District:—

Yellowhead Pass Coal Co., Ltd.,
Yellowhead Pass mine, Coalspur.
Jasper Park Collieries, Ltd.,
Miette mine, Pocahontas.
Mountain Park Coal Co., Ltd.,
Mountain Park mine, Mountain Park.
*Pembina Coal Co., Ltd.,
Evansburgh.
*Gainford Collieries, Ltd.
Gainford.
*Twin City Coal Co., Ltd.,
Edmonton.
*Cardiff Collieries, Ltd.,
Cardiff.
*Tofield Coal Co., Ltd.,
Tofield.

From Drumheller Coal Area:—

Drumheller Coal Co., Ltd.,
Drumheller.
Midland Collieries, Ltd.,
Midland mine, Drumheller.
Newcastle Coal Co., Ltd.,
Newcastle mine, Drumheller.
Rosedale Coal and Clay Products Co., Ltd.,
Rosedale mine, Rosedale.

From the Cascade Coal Area:—
Georgetown Collieries, Ltd.,
Georgetown mine, Canmore.

From the Blairmore-Frank Coal Fields:—

McGillivray Creek Coal and Coke Co., Ltd.,
Carbondale mine, Coleman.
West Canadian Collieries,
Bellevue mine, Blairmore.
West Canadian Collieries, Ltd.,
Greenhill mine, Blairmore.
Franco Canadian Collieries, Ltd.,
Frank mine, Frank.
Hillcrest Collieries, Ltd.,
Hillcrest mine, Hillcrest.

From the Lethbridge Coal Area:—

Chinook Coal Co., Ltd.,
Chinook mine, Commerce.

SUMMARY OF RESULTS

Table I, page 16, gives an abstract of results for all the coals so far tested in the double-zone producer, at the Fuel Testing Station; and at the end of this bulletin a full report on each coal is given.

CONCLUSIONS

The results of the investigation show, that it has been possible to operate the producer for considerable periods with all the fuels tested, except one; but less than one-half can be recommended for continuous operation in this producer. In order that a fuel may be suitable for use under commercial conditions it must be of a character which will permit it to pass regularly through the producer without necessitating excessive poking; it must not pack, cake, or clinker in such a way as to form channels which will prevent the even access of air to all parts of the fuel (this requirement outweighs all others); the coal must be capable of yielding a good quality of gas continuously, which, if required for use in an internal combustion engine, must be fairly free from tar and lampblack. This condition is of great importance, unless the plant installed for generating a power gas for burning in internal combustion engines is large enough to warrant the installation of special scrubbers and tar extractors.

To judge the value of a coal for producer purposes it is not sufficient to consider only the efficiency and calorific value of a gas as reported; a reliable opinion can only be formed after the full report and chart for each trial have been carefully examined. These reports and charts appear at the end of this bulletin.

When examining the results of the trials, it is necessary to bear in mind that they are obtained from tests conducted in a very special and somewhat complicated type of producer. The combustion on the down-draft principle in the upper zone has many drawbacks, and should only be used when it is not feasible to employ an up-draft producer, requiring an elaborate external plant for removing the tar from the gas. Better results are generally to be expected with the simpler up-draft single zone producer; and a fuel unsuited to the double-zone producer may often prove entirely suitable for use in the simpler up-draft producer.

It should, therefore, be borne in mind that some of the fuels which have been reported as unsatisfactory for utilization in this type of producer may prove to be entirely suitable for use in other types of producer; or, in this producer, after the fines have been removed by screening.

However, such fuels will prove more or less satisfactory in other types of producers, or in the double-zone producer after screening the coal, according to the degree of suitability demonstrated in the trials reported.

The addition to the producer of the apparatus for measuring the air and steam supply made its operation simpler, and made it possible to give more valuable information in the report. It is, therefore, recommended for use in conjunction with this type of gas producer.

GENERAL REMARKS ON THE PARTICULAR ALBERTA COALS DEALT WITH, SPECIFICALLY, IN THIS REPORT

Yellowhead Pass.—This coal has a fairly high moisture content, a comparatively low ash content, and a medium calorific value.

Two trials were conducted, Nos. 64 and 65; the latter at one-half the output of the former.

Trial 64 gave better results than trial 65; the efficiency and calorific value of the gas were higher, and the tar content of the gas considerably less. The low efficiency for trial 65 was largely due to an addition to the fuel contents of the producer during the trial. The combustible contents of the refuse removed at the end of trials 64 and 65 were 43·1 and 51·1 per cent, respectively; and it is interesting to note that the efficiency based on these figures, and the analyses of the gas and coal, is 61 instead of 72, for the first trial, and 58 instead of 48, for the second trial. The calorific value of the gas was about one-tenth lower during trial 65 than during 64; and the total variation in calorific value during each trial was about 24 B.Th.U. per cubic foot. There was not much difficulty in operating the producer with this fuel, and the results show that it will give a fairly good gas with an overall efficiency of about 60 per cent.

At the end of trial 64, a sample of the gas which was produced when only the upper zone was in operation, was taken and analysed. The results of this analysis (B); an analysis of the gas taken just previously from both zones (A); and an analysis of the gas from the lower zone only, (C)—calculated from A and B—are appended. The air and steam supplied to the producer when taking these samples was similar to the average supply during the trial.

	A	B	C Calculated from A and B
Sample.			
Time of sampling, a.m.	10.33	10.42	
Zones working	both	top only	bottom only
Carbon dioxide, per cent	12.0	11.1	13.1
Oxygen... "	1.1	0.3	2.1
Carbon monoxide, "	13·6	15·9	10·8
Hydrogen, "	11.0	12.5	9·2
Methane.. "	1·3	1.2	1.4
Nitrogen, "	61.0	59.0	63.4
Calorific value, gross B.Th.U. per cubic foot	92	103	78
" " net cubic foot	85	96	72
Saturation temperature of air blast, top zone, °F	113	113	
Saturation temperature of air blast, lower zone, °F	160		160

The gas formed in the lower zone is thus seen to be leaner than the gas formed in the upper zone, and the process of gasification in the lower zone is less efficient.

Jasper Park.—This coal contains more ash than any of the other coals tested; very little moisture; and has a comparatively high calorific value. A full report of one trial (No. 62), is appended. In this trial the efficiency (81 per cent) is very high. This figure is very misleading, since for every 56 pounds of carbon charged during the trial, 69 pounds left with the gas. This shows that the high efficiency obtained was due only to the depletion of the fuel in the producer during the trial.

The coal did not suit the producer; it caked, and could not be fed properly through the producer. During a subsequent trial these difficulties became so pronounced that it was necessary to stop the trial, because it was impossible to obtain a continuous supply of combustible gas.

Mountain Park.—Two trials, Nos. 119 and 120, were conducted with this coal, the reports of which are appended. The coal contains a fairly high percentage of ash; has a comparatively high calorific value; and contains little moisture. It cakes, and requires considerable poking.

During trial 119 the coal was found to be very suitable for gas producer work; no clinkers were formed, and the only real defect was the necessity of frequent poking. The tar in the gas leaving the producer was oily at first, and in fairly large quantities; but by the end of the trial it was much reduced, and contained very little oil. The gas had, comparatively, a fairly high calorific value, which remained fairly steady during the trial.

Trial 120 was less satisfactory than trial 119. Clinkers formed, which interfered seriously with the operation of the producer, and at one time they held up the coal, forming a large hollow space, which caved in on poking. The gas produced had a calorific value considerably less than in trial 119. The efficiency also was much lower, owing, principally, to the fuel passing, unconsumed, through the producer. It is doubtful if the producer could have been operated for many more hours with this fuel; and it would have then been necessary to clean it out and restart.

Drumheller (Slack).—This is a slack coal, and is composed very largely of dust and fines. The ash and moisture contents are high, and the calorific value very low.

Only one trial (57) was conducted with this coal. Many difficulties were encountered; the coal clinkered badly and packed so tightly that the suction on the producer was very high, even when running at a low rate of gasification. The gas produced, however, was uniform, of fairly good calorific value, and contained little tar. The apparent efficiency was high, but this was undoubtedly due to the depletion of the fuel contents of the producer during the trial. The actual efficiency was much lower. It would have been impossible to operate the producer for many hours after the end of the trial, and there is no doubt that the coal is not suitable for use in this producer.

Midland.—This coal has a low calorific value, and fairly high ash and moisture contents.

It proved an excellent fuel for the producer, however. The gas was very free from tar, of a fairly high calorific value, and was very uniform during the trial. Very little poking was necessary, and while a few clinkers formed they were not troublesome as long as a small amount of steam was mixed with the air blast. The efficiency with this coal for gas production was decidedly good.

Newcastle.—This coal is high in moisture, has a moderate amount of ash, and has a low calorific value.

The gas produced had a comparatively high calorific value, and was fairly uniform throughout the trial. Its tar content at first was rather high and oily, but as the trial proceeded, it decreased, and at the end showed no traces of oil. Towards the end of the trial it was necessary to poke the fuel somewhat frequently in order to have it feed uniformly through the producer. The average resistance in the flow of air through the fuel bed was low, but during the latter half of the trial it rose considerably in the upper zone.

The efficiency of gasification was fairly high, and the coal may be recommended for use in this type of gas producer.

Rosedale.—This coal is high in moisture, fairly high in ash, and has a medium calorific value.

Only one trial was carried through with this coal, namely, 91.

No difficulty was experienced in operating the producer, the suctions on the producer were comparatively low, and no troublesome clinkers were formed. The gas produced was fairly high in calorific value, and contained very little tar.

The recorded efficiency of the gasification process is unduly high, on account of the depletion of the carbon contents of the producer, and the calorific value of the gas varied only slightly during the trial.

This coal may be recommended for use in this type of gas producer. The addition of more steam with the air blast to the lower zone would facilitate the continuous operation of the producer with this fuel.

Carbondale.—This coal contains little moisture, a large proportion of ash, and a fairly high calorific value compared with the other coals tested.

Two trials (95, 96) were conducted, and this coal proved a fairly satisfactory fuel for the producer. The results were very similar for both trials, though the steam supply during the second trial was nearly three times that used in the first. This increase in the steam had little or no effect on the actual efficiency, since the apparently higher efficiency in the second trial is partially due to the depletion of the fuel contents of the producer. It increased the hydrogen content of the gas but the calorific value remained the same, which was largely due to a decrease in the methane present during the second trial. The calorific value of the gas fell considerably towards the end of the first trial, but there was considerably less variation in it during the second. During both trials large quantities of oily tar were present, at times, in the gas. It was necessary to poke the producer frequently, since the coal caked and formed clinker. At the end of the second trial the producer did not contain much clinker, and could have been operated for a longer period.

Bellevue.—This coal contains a fairly large amount of ash, a small amount of moisture, and has a fairly high calorific value compared with the other coals tested.

The first trial (88) lasted for over 90 hours; but it was then necessary to stop because it became impossible to produce a combustible gas. The results are not included in this report.

The second trial (89) is reported in full. The calorific value of the gas was not very high, and deteriorated towards the end of the trial. The coal cakes, clinkers and packs badly, which made it difficult to feed through the producer. It is not recommended for use in this producer.

Greenhill.—This coal has a very high calorific value, contains little moisture, and a medium amount of ash compared with the other coals tested.

It was burned during three trials (97, 98 and 99). At the beginning of the first trial it gave gas of a fairly high calorific value; but as the trial proceeded the calorific value decreased until it reached about 90 B. Th. U. per cubic foot. The calorific value did not improve during the remaining trials. The coal both caked and formed clinkers, which necessitated frequent poking, and was the cause of the poor heating value of the gas. With a view to discovering whether the gas would burn in a gas engine, the second trial was conducted with the gas engine in operation. No difficulties were encountered in running the engine with this gas. For three successive days the engine worked continuously for about 12 hours each day.

During the first two days all the gas was used by the engine, and the B. Th. U. in the gas consumed was 19,000 and 16,000 per kilowatt hour, delivered to the switchboard, by the engine and generator, for loads of 29 and 37 K.W., respectively. The net calorific value of the gas on the first day was 81 B.Th.U. per cubic foot, and on the second day, 91 B.Th.U. per cubic foot. On the third day more gas was produced than the engine could use, and it was not possible to measure the gas consumption of the engine.

The third trial (99), was conducted with a larger proportion of the air supply passing to the lower zone, and at a greater rate of gasification than for trial 97. But the quality of the gas remained throughout about what it was at the end of the first trial, namely, 90 B.Th.U. per cu. ft., and there were still the same difficulties to be encountered, because the coal caked, and did not fall regularly through the producers.

The apparent efficiency during the last trial was higher than in the first. This is misleading, since the actual efficiency must have been lower because the fuel contents of the producer were depleted during the last trial.

The tests show that while this coal is not very suitable for use in this producer, yet, if given much attention, it is capable of giving a continuous supply of rather poor gas.

Frank.—This coal has a fairly high calorific value compared with the other coals tested, contains much ash, and very little moisture.

It is not a suitable fuel for the producer employed. It cakes badly, forms clinker, and moves through the producer only by means of excessive poking. The gas produced during the first trial (86), had a high calorific value, but contained a lot of tar. The apparently high efficiency (69 per cent) was evidently largely due to the depletion of the fuel contents of the producer during the trial, and the actual efficiency must have been lower.

A second trial (87), was started, but soon abandoned. The clinker formed in the producer had gradually increased during the first trial, so that it became impossible to feed the necessary amount of fuel to the producer to obtain a steady supply of gas during the second trial. An attempt to prevent the formation of clinkers by increasing the steam supply was unsuccessful.

Hillcrest.—This coal contains little moisture, a fairly large amount of ash, and has a higher calorific value than most of the coals tested.

During the first trial (116), the coal was burned at about the same rate in both zones. The gas produced at the beginning of the trial was very good, but gradually deteriorated as the trial proceeded. The coal consisted principally of fines which coke together on heating. It was very difficult to get it to feed through the producer properly, and the air for combustion seemed to pass almost entirely along the walls of the producer. The apparent efficiency of gasification was very high. This is to be largely attributed to the depletion of the fuel contents of the producer during the trial, so that the actual efficiency must have been much lower. The gas at times contained much tar, although the average content for the trial was fairly low.

During the second trial (117), the rate of gasification was reduced, and most of the coal was burned in the upper zone. This reduced the necessary rate of feeding of coal through the producer, but the trial was even less satisfactory than the first. At times, the gas was so poor that it would not burn, and contained much tar. The resistance to the flow of air through the upper zone was very high.

This coal proved to be very unsatisfactory for this double-zone producer.

Chinook.—This sample was a lump coal, and contained very little small stuff. Its calorific value was rather low, and its ash and moisture contents fairly high.

It proved an excellent fuel for the producer. The calorific value of the gas remained fairly constant and the average value for the trial was high compared with that obtained during the other trials. At first, the gas contained much tar, but this became less as the trial proceeded. Very little steam was used in the air blast, and the fuel bed resistance to the flow of air remained low throughout the trial.

Georgetown Coal.—Georgetown Collieries, Canmore, Alta. This sample consisted of run-of-mine coal, and the analyses were as follows:—

Approximate analysis. (Coal as charged).		*Ultimate analysis.* (Dry coal).	
Moisture	2·2 per cent.	Carbon	80·0 per cent
Ash	10·8 "	Hydrogen	4·1 "
Volatile matter	13·5 "	Ash	11·0 "
Fixed carbon	73·5 "	Sulphur	0·7 "
		Nitrogen	1·2 "
		Oxygen	3·0 "

The gross calorific value of the coal, as charged, was 13,330 B.Th.U. per pound.

Two trials were started with this coal, and abandoned after a few hours, because it was impossible to obtain a continuous supply of combustible gas.

TABLE I.

Abstract of Results of Gas Producer Trials

No. of trial.	Name of fuel.	Net cal value of fuel as charged B.Th.U. per lb.	Moisture in fuel as charged per cent.	Ash in fuel as charged per cent.	Resistance of upper fuel bed inches of water.	Resistance of lower fuel bed inches of water.	Air supplied to upper zone, per cent of total.	Steam saturation temp. of air to upper zone °Fahr.	Steam saturation temp. of air to lower zone °Fahr.	Steam supplied per lb. of fuel.	CO_2 in gas, per cent by volume.	CO in gas, per cent by volume.	H_2 in gas per cent by volume.	Net cal. val. of gas, B.Th.U. per cu. ft.	Tar in uncleaned gas, grams per 1,000 cu. ft.	Gas produced cu. ft. per hour.	Fuel charged, lbs. per hour.
64	Yellowhead............	10,640	6.1	9.5	2	4	49	115	152	0.50	11.1	14.9	13.1	97	7.8	9,900	126
65	Yellowhead............	10,640	6.1	9.5	0.9	0.5	58	No steam	129	0.11	11.4	11.3	11.1	86	36	4,700	78
62	Jasper Park............	11,740	1.9	18.1	10	1	73	138	137	0.66	10.4	14.6	11.9	90	20	8,400	80
119	Mountain Park.........	12,280	2.4	13.9	6	3	66	141	159	0.93	10.2	14.1	14.2	94	22	6,400	73
120	Mountain Park.........	12,280	2.4	13.9	6	1	77	148	163	0.88	11.0	11.2	12.8	81	16.8	5,700	74
56	Pembina...............	8,410	18.2	10.3	1.4	2.1	....	....	....	....	11.7	16.1	19.0	118	9.5	11,830	177
45	Gainford..............	8,560	17.7	7.7	7	0.5	....	....	....	....	11.2	16.6	15.0	116	9.1	7,610	148
47	Twin City.............	8,600	18.1	7.3	14	7	....	....	....	....	9.4	16.5	11.0	91	5.3	9,260	148
46	Cardiff...............	8,160	20.0	8.0	14	4	....	....	....	....	12.8	13.5	15.3	97	4.5	8,340	130
38	Tofield...............	7,360	25.0	8.5	14.4	2.5	....	....	....	....	12.5	10.6	14.6	90	10.6	7,120	121
39	Tofield...............	7,360	25.0	8.5	19	6.1	....	....	....	....	12.5	12.2	14.1	94	12.9	6,700	122
57	Drumheller............	7,810	18.9	14.8	17	3	76	No steam	147	0.14	11.4	13.1	12.5	93	12	6,600	111
118	Midland...............	8,960	15.7	10.0	3	0.7	64	122	143	0.29	10.7	15.6	17.4	107	3.5	7,800	129
66	Newcastle.............	8,890	17.5	8.2	6	1	81	No steam	144	0.07	9.4	16.9	15.1	111	8.4	9,200	172
40	Rosedale..............	9,100	16.5	6.5	4	1	....	....	....	....	10.4	17.3	16.7	120	23.4	8,070	151
91	Rosedale..............	8,840	18.8	7.9	0.8	8	54	No steam	88	0.02	8.5	18.3	15.7	115	8.5	9,100	149
95	McGillivray Creek.....	11,690	2.5	16.4	5	4	48	No steam	120	0.17	6.6	17.8	8.9	99	14.5	8,300	103
96	McGillivray Creek.....	11,690	2.5	16.4	3.5	2	52	130	134	0.49	8.2	17.4	11.7	99	....	7,100	80
89	Béllevue..............	11,660	2.7	16.7	2	4	50	115	112	0.26	8.0	17.8	9.0	90	10.3	8,850	102
97	Greenhill.............	12,750	2.4	11.3	3.5	2	61	135	139	0.58	8.6	15.8	13.3	95	11.6	6,600	79
99	Greenhill.............	12,750	2.4	11.3	5.5	2	35	128	143	0.58	9.7	15.0	11.3	87	14.5	8,300	81
86	Franck................	11,530	2.3	18.1	5	2	48	117	136	0.45	8.9	16.7	12.0	99	34	6,500	80
116	Hillcrest.............	12,310	1.9	14.4	3	2	51	130	145	0.62	9.4	15.1	12.4	91	9.9	9,000	91
117	Hillcrest.............	12,310	1.9	14.4	13.5	3	65	136	139	0.51	10.5	11.6	10.8	75	19.0	6,900	106
92	Chinook...............	9,570	9.4	14.9	3.5	0.5	25	No steam	138	0.16	8.5	18.6	15.3	112	12.0	8,250	124

TABLE II.

Detailed Report of Trials

Particulars of Trial						Particulars of Gas Producer					
						Cross sectional area of the fuel bed			Average height of fuel level above gas outlet	Height of gas outlet above the tuyere	Size of fuel
No. of Trial	Name of Fuel	Date when fuel was received	Date of the trial	Duration of trial	Rate of gasification	Mean for the upper zone	Mean for the lower zone	Average of both zones			
1	2	3	4	5	6	7	8	9	10	11	12
				hours	cu. ft. per hour	sq. ft.	sq. ft.	sq. ft.	inches	inches	
64	Yellowhead	May 27, 1914	March 2, 1915	96	9,900	8.5	21	15	68	56	run of mine
65	Yellowhead	May 27, 1914	March 9, 1915	78	4,700	8.5	21	15	69	56	run of mine
62	Jasper Park	Jan. 19, 1915	Feb. 9, 1915	72	8,400	8.5	21	15	72	56	run of mine
119	Mountain Park	May 17, 1916	July 10, 1917	96	6,400	8.5	21	15	50	56	run of mine
120	Mountain Park	May 17, 1916	July 16, 1917	96	5,700	8.5	21	15	46	56	run of mine
56	Pembina	....	April 29, 1914	72	11,830	8.5	21	15	72	56	run of mine
45	Gainford	Sept. 12, 1912	Aug. 25, 1913	72	7,600	8.5	21	15	56	56	run of mine
47	Twin City	Aug. 30, 1912	Sept. 9, 1913	72	9,300	8.5	21	15	56	56	run of mine
46	Cardiff	Aug. 29, 1912	Sept. 2, 1913	72	8,300	8.5	21	15	59	56	run of mine
38	Tofield	Jan. 25, 1913	June 19, 1913	51.5	7,100	8.5	21	15	....	56	lump
39	Tofield	Jan. 25, 1913	July 2, 1913	72	6,700	8.5	21	15	61	56	lump
57	Drumheller	June 10, 1914	Jan. 19, 1915	72	6,600	8.5	21	15	56	56	slack
118	Midland	Sept. 30, 1915	June 12, 1917	96	7,800	8.5	21	15	47	56	run of mine
66	Newcastle	Oct. 17, 1914	March 23, 1915	96	9,200	8.5	21	15	54	56	run of mine
40	Rosedale	Dec. 18, 1912	July 14, 1913	72	8,100	8.5	21	15	54	56	run of mine
91	Rosedale	Nov. 16, 1915	Feb. 22, 1916	72	9,100	8.5	21	15	58	56	run of mine
95	Carbondale	May 13, 1914	April 11, 1916	72	8,300	8.5	21	15	60	56	run of mine
96	Carbondale	May 13, 1914	May 3, 1916	72	7,100	8.5	21	15	58	56	run of mine
89	Bellevue	Nov. 19, 1914	Jan. 26, 1916	72	8,550	8.5	21	15	55	56	run of mine
97	Greenhill	March 1, 1915	May 23, 1916	96	6,600	8.5	21	15	55	56	run of mine
99	Greenhill	March 1, 1915	June 6, 1916	96	8,300	8.5	21	15	56	56	run of mine
86	Frank	Nov. 24, 1914	Nov. 30, 1915	96	6,500	8.5	21	15	57	56	run of mine
116	Hillcrest	Jan. 5, 1916	May 22, 1917	96	9,000	8.5	21	15	48	56	run of mine
117	Hillcrest	Jan. 5, 1916	May 29, 1917	80	6,900	8.5	21	15	39	56	run of mine
92	Chinook	Oct. 18, 1915	March 8, 1916	72	8,250	8.5	21	15	61	56	lump

Detailed Report of Trials—Continued

No. of Trial	Name of Fuel	Particulars of the Fuel: Analysis (by weight) as fired: Ultimate: Carbon	Hydrogen	Ash.	Sulphur	Oxygen	Nitrogen	Proximate: Fixed carbon	Volatile matter	Ash	Moisture	Calorific Value of fuel per lb.: As fired: Gross	Net	Dry gross	*Combustible gross
1	2	13	14	15	16	17	18	19	20	21	22	23	24	25	26
		per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	B. Th. U.	B. Th. U.	B. Th. U.	B. Th. U.
64	Yellowhead	65.4	4.7	9.5	0.2	19.5	0.7	48.7	35.7	9.5	6.1	11,090	10,640	11,800	13,150
65	Yellowhead	65.4	4.7	9.5	0.2	19.5	0.7	48.7	35.7	9.5	6.1	11,090	10,640	11,800	13,150
62	Jasper Park	70.2	4.2	18.1	0.8	5.6	1.1	60.7	19.3	18.1	1.9	12,140	11,740	12,370	15,180
119	Mountain Park	72.5	4.6	13.9	0.3	7.6	1.1	59.8	23.9	13.9	2.4	12,720	12,280	13,040	15,200
120	Mountain Park	72.5	4.6	13.9	0.3	7.6	1.1	59.8	23.9	13.9	2.4	12,720	12,280	13,040	15,200
56	Pembina	53.9	5.5	10.3	0.2	......	......	43.9	27.6	10.3	18.2	8,930	8,410	10,910	12,490
45	Gainford	53.8	5.1	7.7	0.6	31.2	1.6	43.8	30.8	7.7	17.7	9,040	8,560	10,980	12,120
47	Twin City	54.1	5.9	7.3	0.4	31.2	1.1	41.3	33.3	7.3	18.1	9,160	8,600	11,180	12,280
46	Cardiff	52.1	6.4	8.0	0.2	32.2	1.1	40.4	31.6	8.0	20.0	8,770	8,160	10,960	12,180
38	Tofield	50.4	6.6	8.5	0.3	33.3	0.9	36.7	29.8	8.5	25.0	7,990	7,360	10,650	12,020
39	Tofield	50.4	6.6	8.5	0.3	33.3	0.9	36.7	29.8	8.5	25.0	7,990	7,360	10,650	12,020
57	Drumheller	49.2	5.5	14.8	0.4	29.1	1.0	38.0	28.3	14.8	18.9	8,330	7,810	10,270	12,560
118	Midland	56.0	5.4	10.0	0.4	26.9	1.3	44.7	29.6	10.0	15.7	9,470	8,960	11,240	12,750
66	Newcastle	55.2	5.5	8.2	0.4	29.6	1.1	42.8	31.5	8.2	17.5	9,410	8,890	11,400	12,660
40	Rosedale	57.3	5.8	6.5	0.4	28.7	1.3	43.4	33.6	6.5	16.5	9,650	9,100	11,560	12,530
91	Rosedale	54.7	5.6	7.9	0.5	29.9	1.4	44.9	28.4	7.9	18.8	9,370	8,840	11,540	12,780
95	Carbondale	69.7	4.5	16.4	0.7	7.7	1.0	56.9	24.2	16.4	2.5	12,120	11,690	12,430	14,950
96	Carbondale	69.7	4.5	16.4	0.7	7.7	1.0	56.9	24.2	16.4	2.5	12,120	11,690	12,430	14,950
89	Bellevue	69.7	4.6	16.7	0.6	7.4	1.0	54.4	26.2	16.7	2.7	12,100	11,660	12,440	15,010
97	Greenhill	75.6	4.6	11.3	0.6	6.9	1.0	61,4	24.9	11.3	2.4	13,190	12,750	13,520	15,280
99	Greenhill	75.6	4.6	11.3	0.6	6.9	1.0	61.4	24.9	11.3	2.4	13,190	12,750	13,520	15,280
86	Frank	68.2	4.4	18.1	0.6	7.8	0.9	53.3	26.3	18.1	2.3	11,950	11,530	12,230	15,010
116	Hillcrest	71.7	4.5	14.4	0.6	7.7	1.1	58.6	25.1	14.4	1.9	12.740	12,310	12,980	15,220
117	Hillcrest	71.7	4.5	14.4	0.6	7.7	1.1	58.6	25.1	14.4	1.9	12,740	12,310	12,980	15,220
92	Chinook	57.8	5.2	14.9	0.7	20.0	1.4	44.8	30.9	14.9	9.4	10,060	9,570	11,100	13,300

*"Combustible" means "Ash and Moisture Free Fuel."

Detailed Report of Trials—Continued

No. of Trial	Name of Fuel.	Air and Steam Supply, etc.									Total Quantities	
		Steam saturation temperature of air supply to		Temperature of air and steam entering lower zone	Resistance of			Temperature of gas leaving producer	Air supplied to		Fuel charged during trial corrected for change in level	Gas (moist at 14·7 lbs. per sq. in. and 60° F.) produced during trial
		Upper zone	Lower zone		Upper fuel bed	Lower fuel bed	Wet scrubber		Upper zone per cent of total	Lower zone per cent of total		
1	2	27	28	29	30	31	32	33	34	35	36	37
		°F.	°F.	°F.	in. of water	in. of water	in. of water	°F.			lbs.	cu. ft.
64	Yellowhead........	115	152	....	2.0	4.0	4.0	560	49	51	12,090	947,000
65	Yellowhead........	No steam	129	....	0.9	0.5	3.0	260	58	42	6,120	365,000
62	Jasper Park........	138	137	....	10.0	1.0	5.0	440	73	27	5,730	608,000
119	Mountain Park......	141	159	219	5.7	2.7	8.8	420	66	34	6,987	610,000
120	Mountain Park......	148	163	204	5.7	1.2	8.3	370	77	23	7,086	550,000
56	Pembina..........	....	....	....	2.3	3.0	....	510	....	....	12,727	851,600
45	Gainford..........	....	....	....	6.6	0.5	....	390	....	....	10,686	548,010
47	Twin City..........	....	....	....	14.1	7.2	....	520	....	....	10,641	666,790
46	Cardiff............	....	....	....	14.0	3.6	....	460	....	....	9,320	600,640
38	Tofield............	....	....	....	14.4	2.5	....	427	....	....	6,215	366,680
39	Tofield............	....	....	....	19.0	6.1	....	408	....	....	8,761	482,360
57	Drumheller........	....	147	....	17.0	3.0	9.0	340	76	24	7,990	475,000
118	Midland...........	122	143	262	2.9	0.7	9.6	250	64	36	12,419	750,000
66	Newcastle..........	No steam	144	....	6.0	1.0	4.0	510	81	19	16,490	883,000
40	Rosedale..........	....	....	....	4.0	0.7	....	440	....	....	10,884	580,530
91	Rosedale..........	No steam	88	....	0.8	8.3	8.5	430	54	46	10,760	653,000
95	Carbondale........	No steam	120	....	5.0	4.0	9.0	500	48	52	7,399	590,000
96	Carbondale...... ..	130	134	....	3.5	2.2	8.8	460	52	48	5,730	510,000
89	Bellevue..........	115	112	....	2.0	4.0	8.0	630	50	50	7,340	637,000
97	Greenhill..........	135	139	....	3.5	1.8	8.7	490	61	39	7,600	638,000
99	Greenhill..........	128	143	....	5.5	2.3	8.3	680	35	65	7,742	791,000
86	Frank.............	117	136	....	5.0	2.0	8.0	460	48	52	7,660	624,000
116	Hillcrest..........	130	145	246	3.3	2.3	9.4	530	51	49	8,693	860,000
117	Hillcrest..........	136	139	169	13.5	2.8	9.0	660	65	35	8,483	550,000
92	Chinook...........	No steam	138	....	3.5	0.5	8.6	440	25	75	8,946	594,000

Detailed Report of Trials—Continued

No. of Trial	Name of Fuel.	Quality of the gas												
		Analysis of gas, by volume								Calorific value moist at 14·7 lbs. per sq. in. and 60° F. per cu. ft.		Ratio oxygen present which is derived from the air and combined with carbon to total oxygen combined with carbon	Tar, per 1,000 cu. ft. in	
		Carbon dioxide	Carbon monoxide	Hydrogen	Methane	Ethylene	Oxygen	Nitrogen	Inflammable gas	Gross	Net		Uncleaned gas	Cleaned gas
1	2	38	39	40	41	42	43	44	45	46	47	48	49	50
		per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	B. Th. U.	B. Th. U.		grams	grams
64	Yellowhead.........	11.1	14.9	13.1	1.4	0.1	1.1	58.3	29.5	105	97	0.77	7.8	0.66
65	Yellowhead.........	11.4	11.3	11.1	1.9	0.2	1.8	62.3	24.5	94	86	0.86	36.0	3.9
62	Jasper Park..........	10.4	14.6	11.9	1.1	0.0	1.2	60.8	27.6	97	90	0.84	20.0	4.8
119	Mountain Park......	10.2	14.1	14.2	1.1	0.0	1.6	58.8	29.4	103	94	0.81	22.0	9.7
120	Mountain Park......	11.0	11.2	12.8	1.0	0.0	2.0	62.0	25.0	88	81	0.87	16.8	4.7
56	Pembina.............	11.7	16.1	19.0	1.5	0.1	0.7	50.9	36.7	129	118	0.65	9.5	2.7
45	Gainford............	11.2	16.6	15.0	2.4	0.1	0.7	54.0	34.1	126	116	0.70	9.1	1.5
47	Twin City...........	9.4	16.5	11.0	0.8	0.1	1.5	60.7	28.4	97	91	0.83	5.3	0.2
46	Cardiff..............	12.8	13.5	15.3	1.4	0.0	1.0	56.0	30.2	106	97	0.71	4.5	0.1
38	Tofield..............	12.5	10.6	14.6	1.8	0.0	2.4	58.1	27.0	100	90	0.73	10.6	1.0
39	Tofield..............	12.5	12.2	14.1	1.7	0.0	1.7	57.8	28.0	103	94	0.74	12.9	0.6
57	Drumheller..........	11.4	13.1	12.5	1.8	0.0	1.5	59.7	27.4	101	93	0.80	12.0	0.55
118	Midland.............	10.7	15.6	17.4	1.2	0.0	1.6	53.5	34.2	117	107	0.68	3.5	0.38
66	Newcastle...........	9.4	16.9	15.1	1.6	0.1	1.7	55.2	33.7	120	111	0.72	8.4	2.0
40	Rosedale............	10.4	17.3	16.7	2.1	0.0	0.5	53.0	36.1	131	120	0.72	23.4	7.9
91	Rosedale............	8.5	18.3	15.7	1.4	0.1	1.1	54.9	35.5	125	115	0.77	8.5	2.3
95	Carbondale..........	6.6	17.8	8.9	1.6	0.2	1.6	63.3	28.5	105	99	0.98	14.5	5.7
96	Carbondale..........	8.2	17.4	11.7	1.1	0.1	1.5	60.0	30.3	106	99	0.86	....	5.9
89	Bellevue............	8.0	17.8	9.0	0.9	0.0	1.0	63.3	27.7	95	90	0.94	10.3	1.7
97	Greenhill...........	8.6	15.8	13.3	0.7	0.1	1.6	59.9	29.9	102	95	0.87	11.6	9.4
99	Greenhill...........	9.7	15.0	11.3	0.85	0.05	1.2	61.9	27.2	94	87	0.89	14.5	2.3
86	Frank................	8.9	16.7	12.0	1.3	0.1	1.4	59.6	30.1	107	99	0.83	34.0	7.3
116	Hillcrest............	9.4	15.1	12.4	1.1	0.0	1.9	60.1	28.6	98	91	0.83	9.9	6.8
117	Hillcrest............	10.5	11.6	10.8	0.8	0.1	2.3	63.9	23.3	82	75	0.90	19.0	5.8
92	Chinook.............	8.5	18.6	15.3	1.1	0.1	0.9	55.5	35.1	122	112	0.78	12.0	3.3

Detailed Report of Trials—Continued

No. of Trial	Name of fuel	Hourly Quantities											
		Fuel charged (corrected for level)	Dry fuel charged	*Combustible charged	Carbon charged	Carbon leaving as permanent gas	Tar in		Nitrogen		Gas (moist at 14·7 lbs. per sq. in. and 60° F.) produced	Total calorific value (net)	
							Uncleaned gas	Cleaned gas	As ammonia in uncleaned gas	In coal charged		Coal charged	Gas produced
1	2	51	52	53	54	55	56	57	58	59	60	61	62
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	cu. ft.	B.Th.U.	B.Th.U.
64	Yellowhead	126	118	106	82	85	0.17	0.01	0.35	0.9	9,900	1,340,000	960,000
65	Yellowhead	78	74	66	51	36	0.37	0.04	0.21	0.6	4,700	830,000	400,000
62	Jasper Park	80	78	64	56	69	0.37	0.09	0.12	0.9	8,400	940,000	760,000
119	Mountain Park	73	71	61	53	50	0.31	0.14	0.17	0.8	6,400	890,000	600,000
120	Mountain Park	74	72	62	54	41	0.21	0.06	0.18	0.81	5,700	910,000	460,000
56	Pembina	177	145	126	95	92	0.25	0.0704	0.605	....	11,830	1,486,000	1,396,000
45	Gainford	148	122	111	80	72	0.15	0.03	0.36	2.37	7,600	1,260,000	880,000
47	Twin City	148	121	110	80	78	0.11	0.004	0.031	1.63	9,260	1,272,000	840,000
46	Cardiff	130	104	93	68	72	0.08	0.002	0.17	1.4	8,340	1,060,000	810,000
38	Tofield	121	91	80	61	56	0.17	0.016	0.17	1.08	7,120	891,000	645,000
39	Tofield	122	91	81	61	55	0.19	0.01	0.22	1.1	6,700	898,000	630,000
57	Drumheller	111	90	74	55	54	0.17	0.008	0.23	1.1	6,600	868,000	610,000
118	Midland	129	109	96	72	67	0.061	0,0065	0.50	1.7	7,800	1,160,000	834,000
66	Newcastle	172	142	128	95	81	0.17	0.04	0.36	1.9	9,200	1,530,000	1,020,000
40	Rosedale	151	126	116	87	75	0.42	0.14	0.42	1.96	8,070	1,375,000	970,000
91	Rosedale	149	121	109	82	81	0.16	0.046	0.23	2.1	9,100	1,320,000	1,050,000
95	Carbondale	103	100	83	72	68	0.27	0.10	0.01	1.03	8,300	1,200,000	820,000
96	Carbondale	80	78	65	55	59	....	0.09	....	0.8	7,100	970,000	700,000
89	Bellevue	102	99	82	71	74	0.2	0.034	0.048	1.0	8,850	1,190,000	796,000
97	Greenhill	79	77	68	60	52	0.17	0.14	0.10	0.79	6,600	1,010,000	630,000
99	Greenhill	81	79	70	61	66	0.27	0.042	0.057	0.80	8,300	1,030,000	720,000
86	Frank	80	78	63	55	55	0.49	0.10	0.056	0.72	6,500	922,000	640,000
116	Hillcrest	91	89	76	65	72	0.20	0.13	0.11	1.0	9,000	1,110,000	819,000
117	Hillcrest	106	104	89	76	50	0.29	0.089	0.15	1.2	6,900	1,300,000	520,000
92	Chinook	124	113	94	72	75	0.22	0.062	0.29	1.7	8,250	1,190,000	920,000

*"Combustible" means "Ash and Moisture Free Fuel."

Detailed Report of Trials—Continued

No. of Trial	Name of Fuel	Economic Results: Gas (moist at 14·7 lbs. per sq. in and 60° F), produced per lb. of Fuel as charged	Dry fuel	*Combustible	Steam supplied with air blast per lb. of fuel as charged	Nitrogen recovered as ammonia, per cent of nitrogen in fuel charged	Fuel charged per 10,000 B.Th.U. in gas produced (net calorific values)	Efficiency of process of gas production based on fuel charged and: Net calorific values of the gas and fuel	Gross calorific values of the gas and fuel
1	2	63	64	65	66	67	68	69	70
		cu. ft.	cu. ft.	cu. ft.	lbs.		lbs.	per cent	per cent
64	Yellowhead	79	84	93	0.50	30	1.3	72	74
65	Yellowhead	60	64	71	0.11	35	2.0	48	51
62	Jasper Park	106	108	133	0.66	13	1.1	81	84
119	Mountain Park	87	89	104	0.93	21	1.2	67	70
120	Mountain Park	78	80	93	0.88	22	1.6	51	54
56	Pembina	67	82	94	....	....	1.27	94	97
45	Gainford	51	62	69	....	15	1.7	69	72
47	Twin City	63	77	84	....	1.9	1.8	66	66
46	Cardiff	64	81	89	....	12.2	1.6	76	78
38	Tofield	59	79	89	....	16	1.9	72	74
39	Tofield	55	73	83	....	19.6	1.9	70	71
57	Drumheller	59	73	89	0.14	21	1.8	70	72
118	Midland	60	71	81	0.29	29	1.6	72	74
66	Newcastle	54	65	72	0.07	19	1.7	67	68
40	Rosedale	53	64	69	....	21.2	1.6	70	72
91	Rosedale	61	75	83	0.02	11	1.4	79	81
95	Carbondale	80	83	99	0.17	1.0	1.3	68	69
96	Carbondale	89	91	109	0.49	....	1.1	72	78
89	Bellevue	87	89	107	0.26	4.8	1.3	67	68
97	Greenhill	84	86	97	0.58	13	1.3	62	65
99	Greenhill	102	105	118	0.58	7.1	1.1	70	73
86	Frank	81	83	103	0.45	7.8	1.2	69	73
116	Hillcrest	99	101	119	0.62	11	1.1	73	76
117	Hillcrest	65	66	77	0.51	12	2.0	40	42
92	Chinook	67	73	88	0.16	17	1.3	78	81

*"Combustible" means "Ash and Moisture Free Fuel."

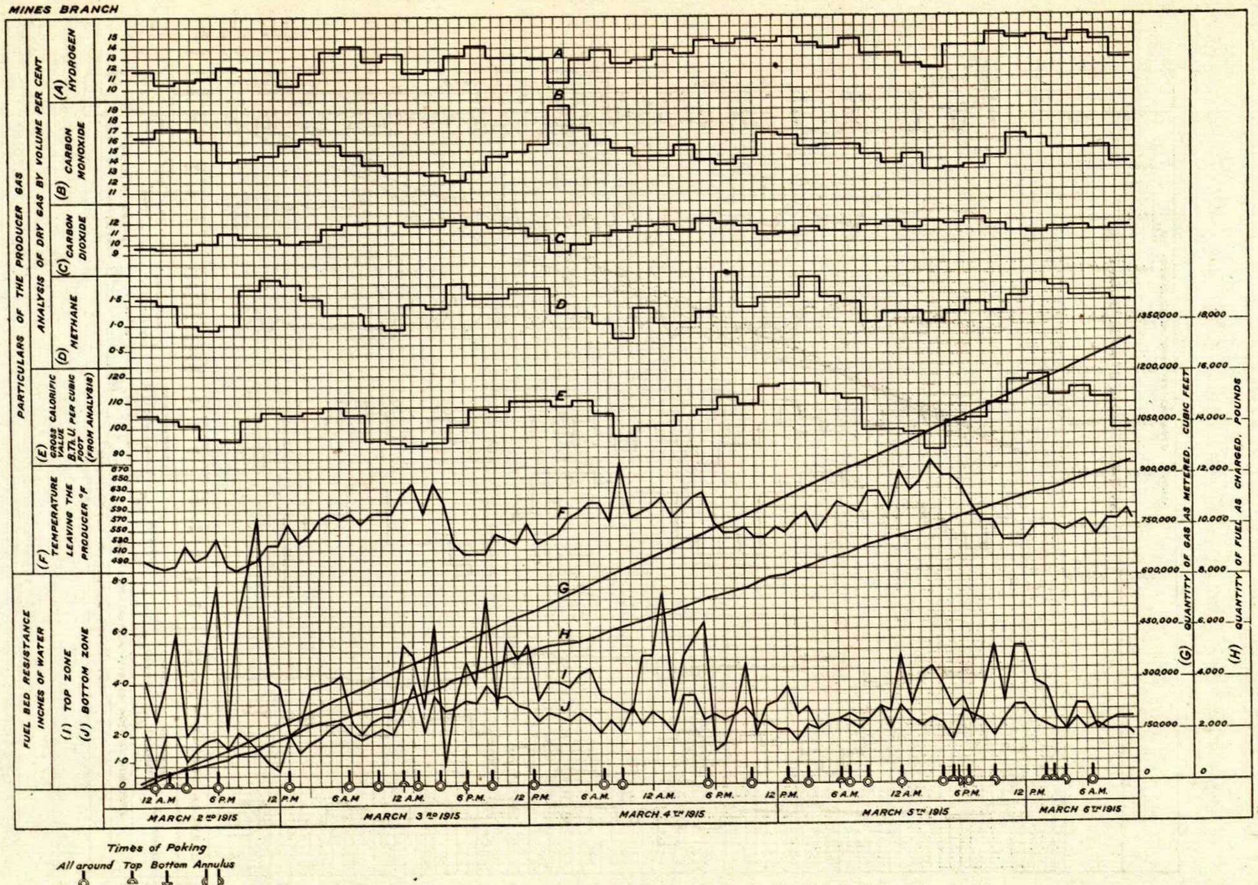

Chart No. 1. Trial No. 64: Fuel—Yellowhead Pass Coal and Coke Co., Ltd

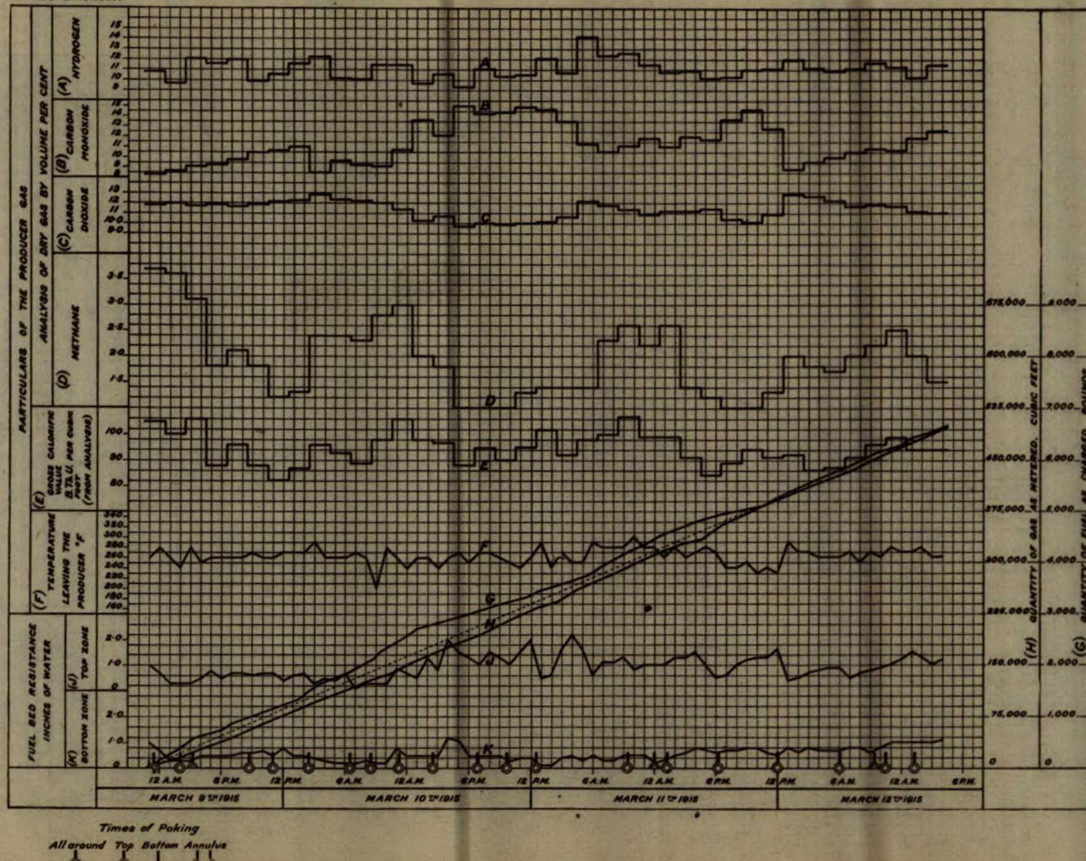

Chart No. 2. Trial No. 65: Fuel—Yellowhead Pass Coal and Coke Co., Ltd.

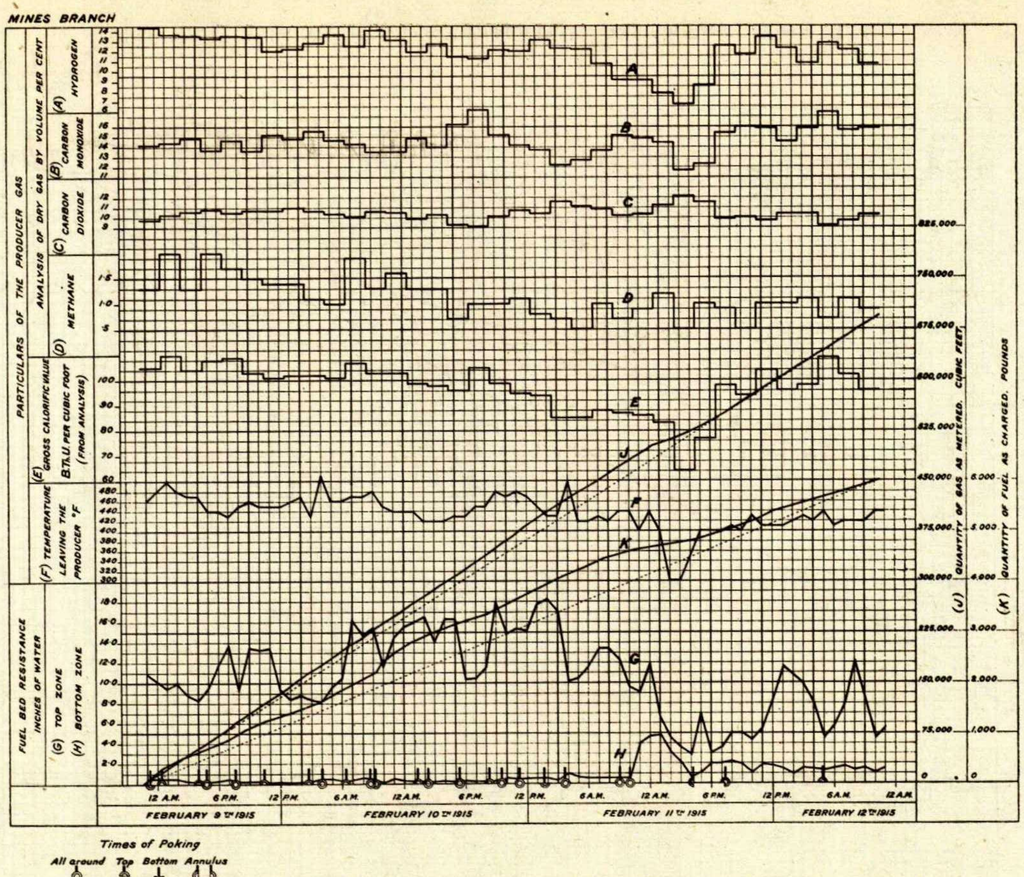

Chart No. 3. Trial No. 62: Fuel—Jasper Park Collieries, Ltd. Producer—Westinghouse double-zone.

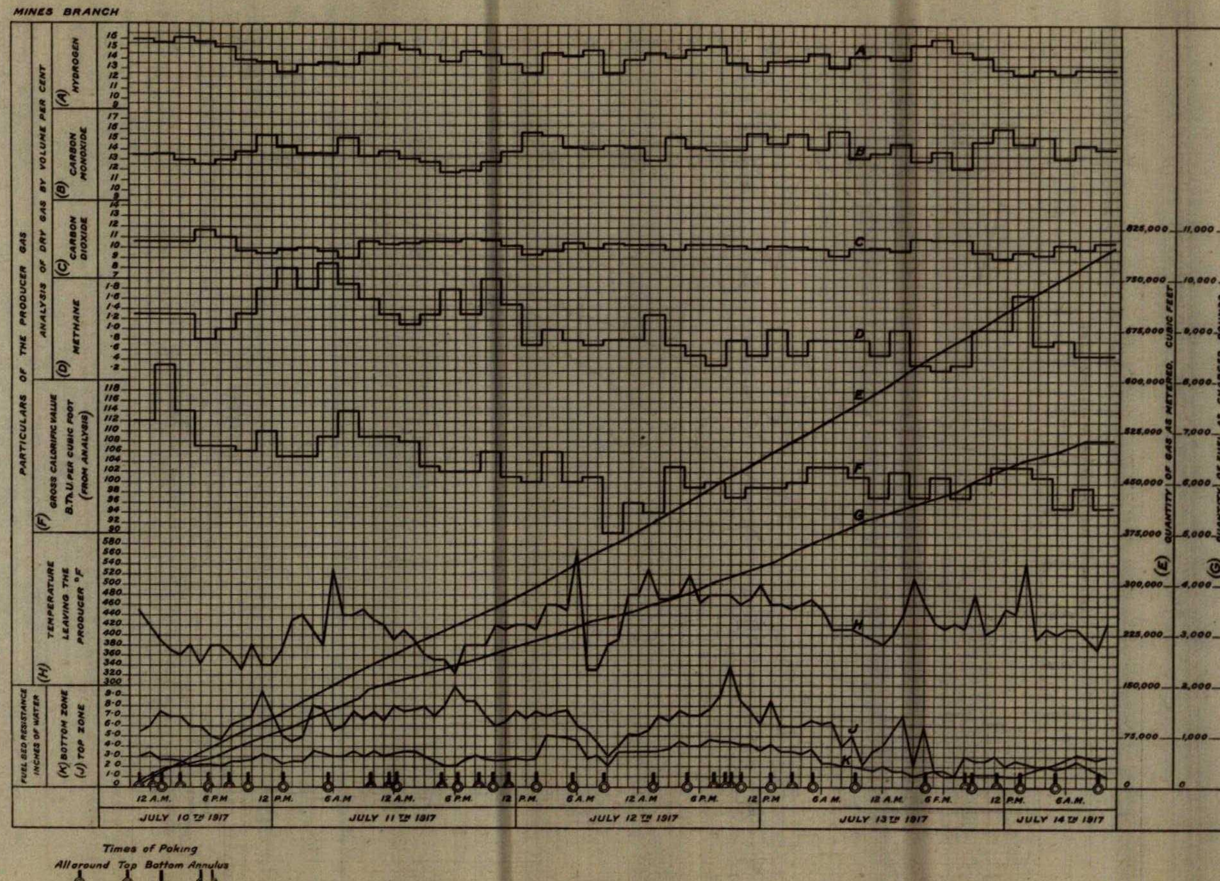

Chart No. 4. Trial No. 119: Fuel—Mountain Park, Mountain Park Collieries, Ltd.

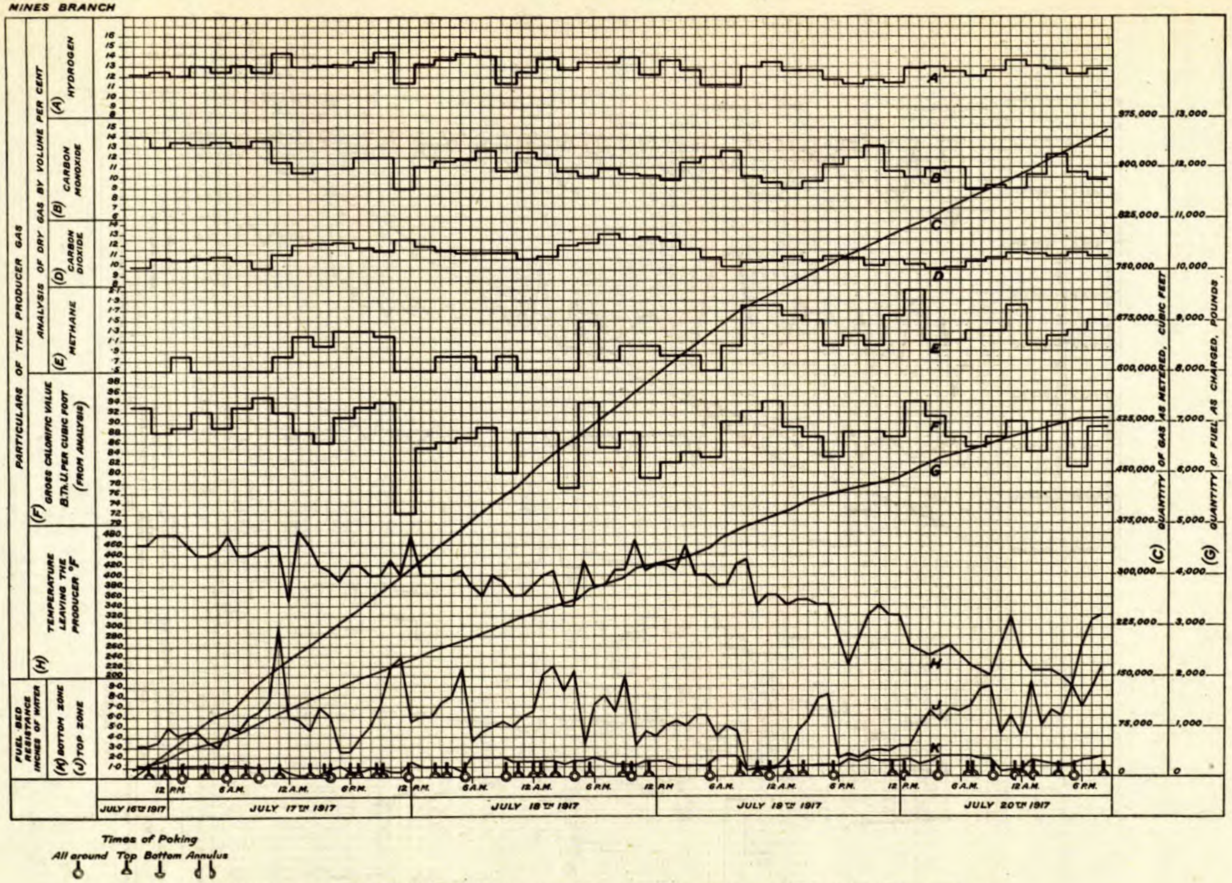

Chart No. 5. Trial No. 120: Fuel—Mountain Park, Mountain Park Collieries, Ltd.

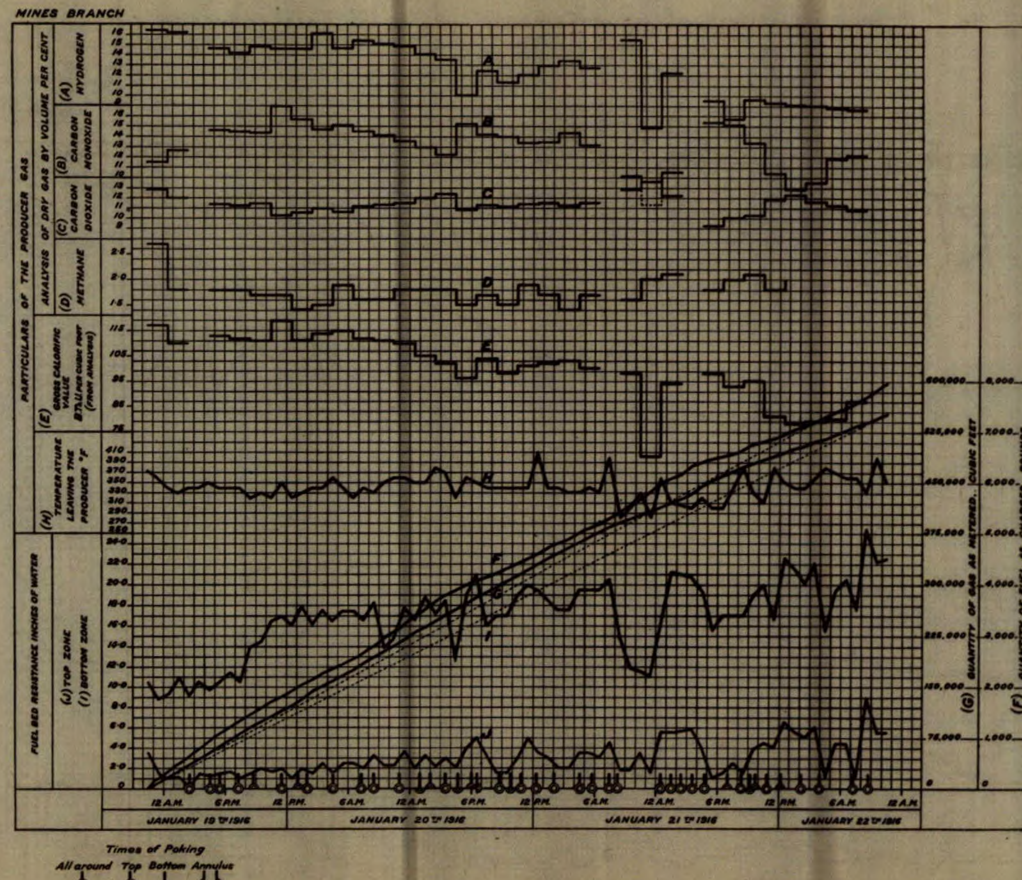

Chart No. 6. Trial No. 57: Fuel—Drumheller Coal Co., Ltd.

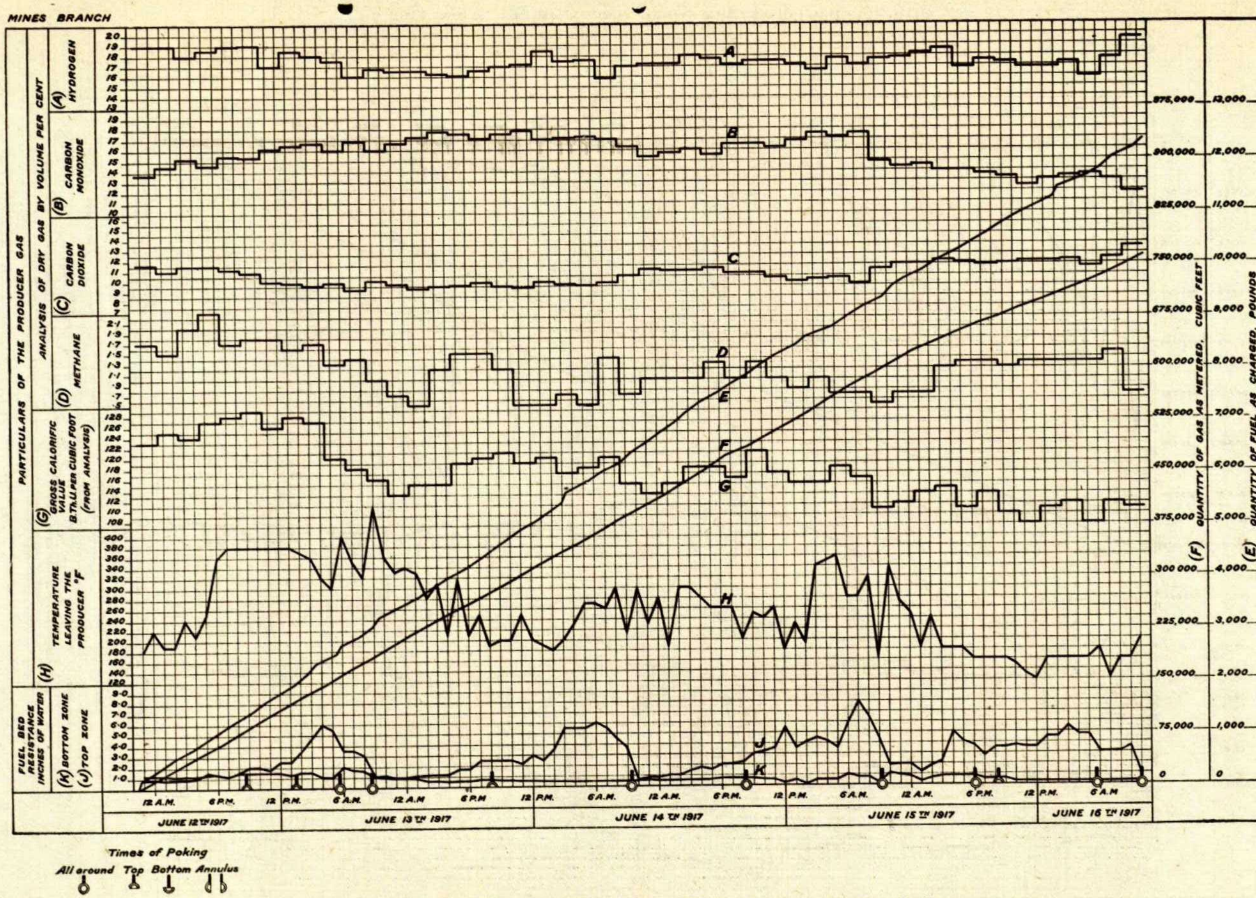

Chart No. 7. Trial No. 118: Fuel—Midland Collieries Co., Ltd.

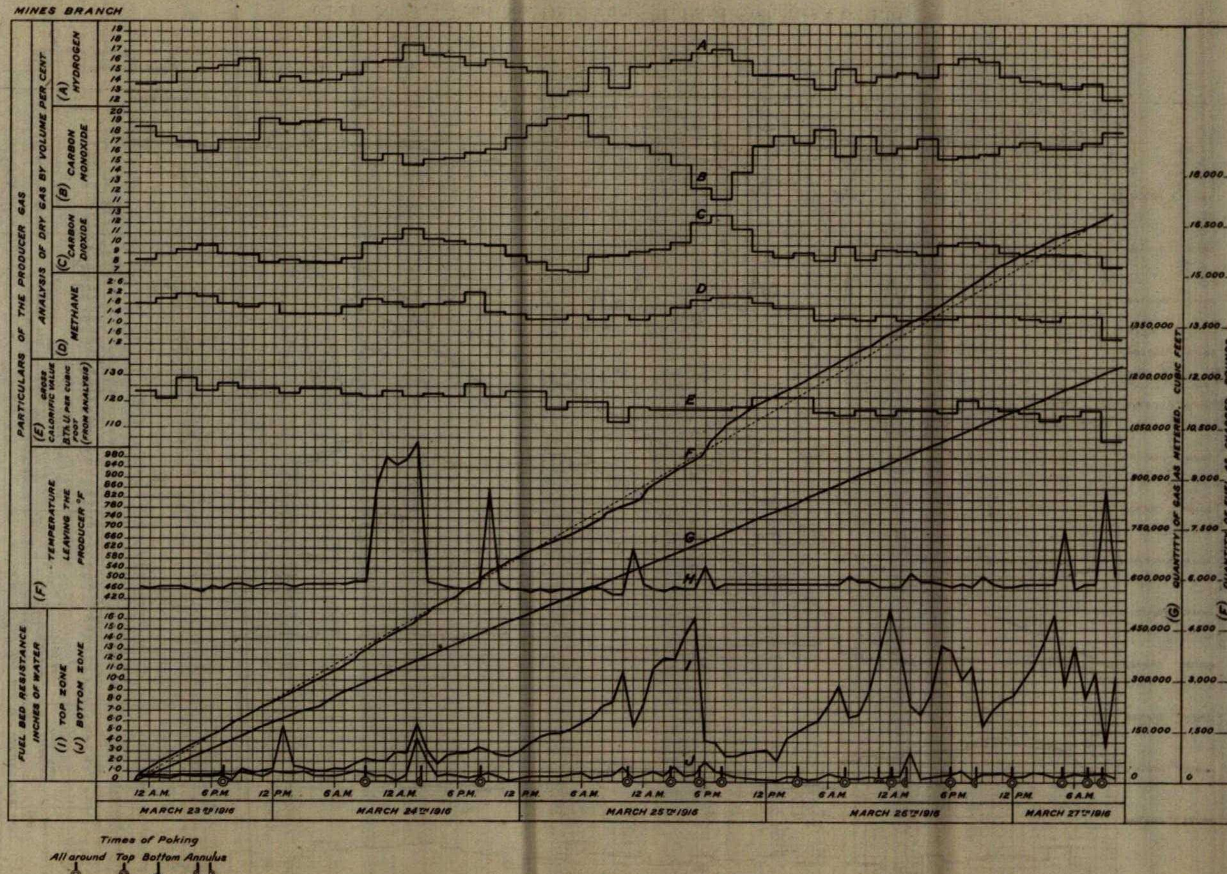

Chart No. 8. Trial No. 66: Fuel—Newcastle Coal Co., Ltd.

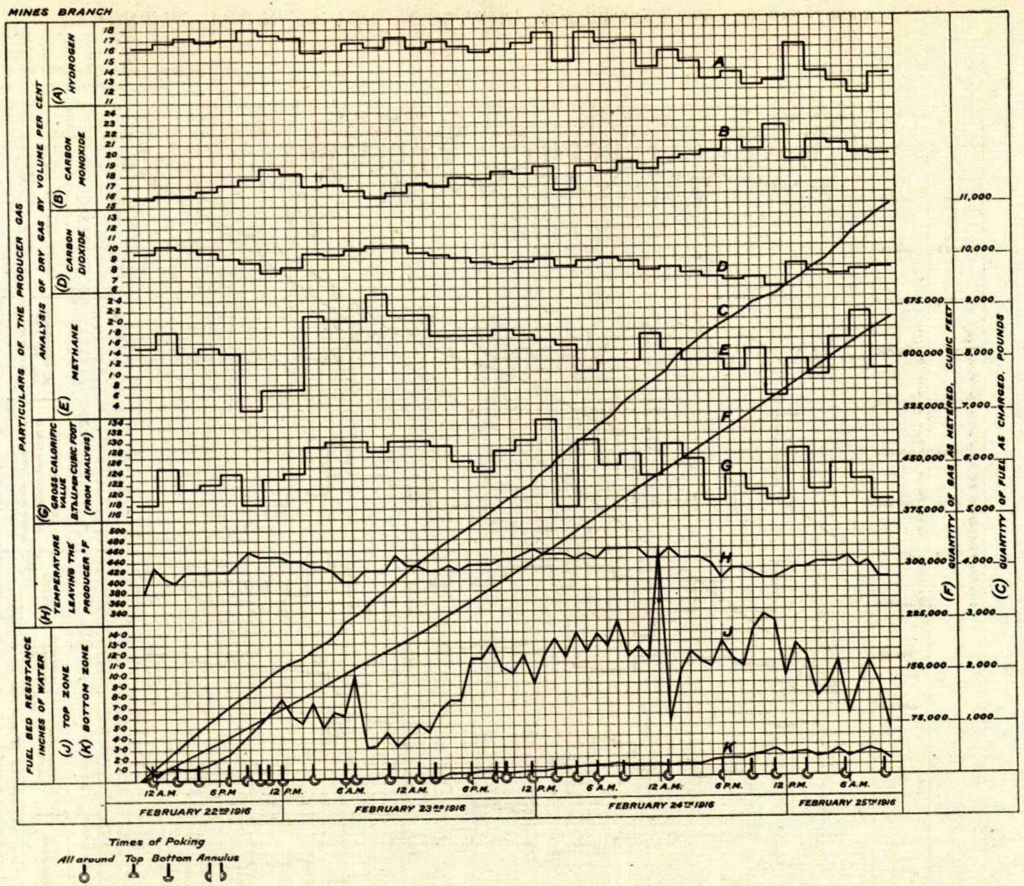

Chart No. 9. Trial No. 91: Fuel—Rosedale Coal and Clay Products Co., Ltd.

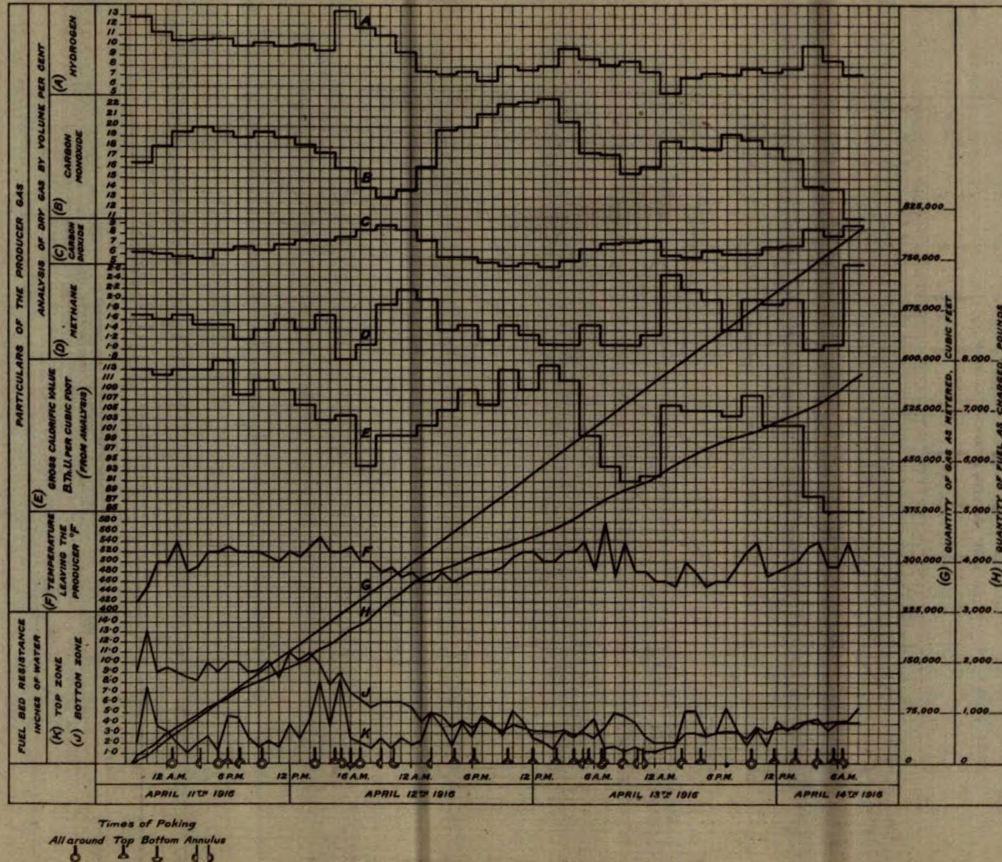

Chart No. 10. Trial No. 95: Fuel—"Carbondale," McGillivray Creek Coal and Coke Co.

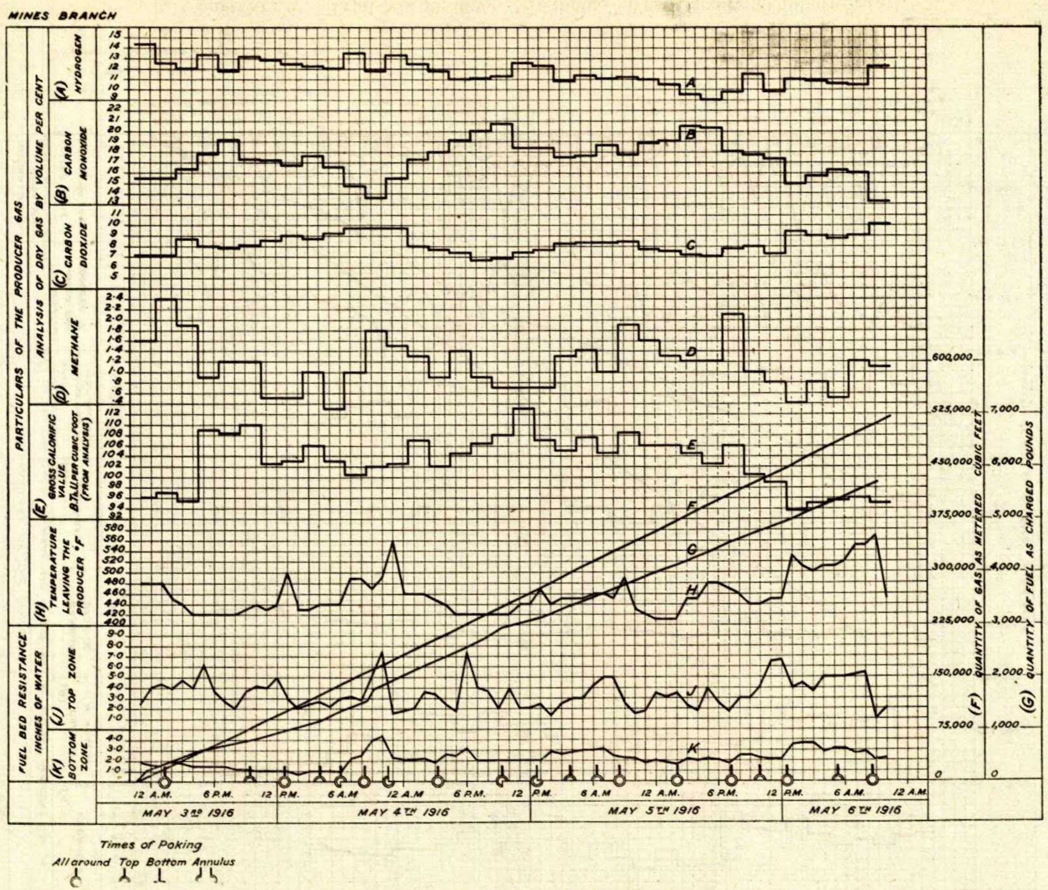

Chart No. 11. Trial No. 96: Fuel—"Carbondale," McGillivray Creek Coal and Coke Co.

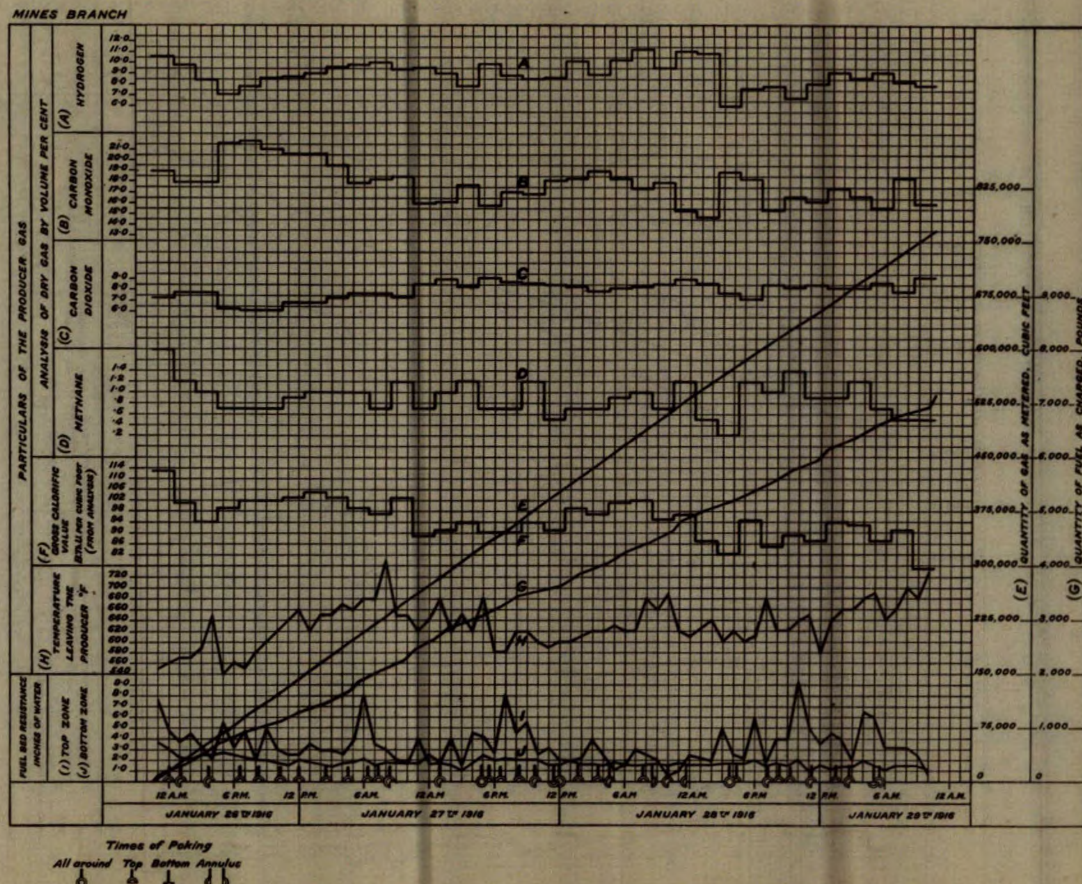

Chart No. 12. Trial No. 89: Fuel—"Bellevue" West Canadian Collieries, Ltd.

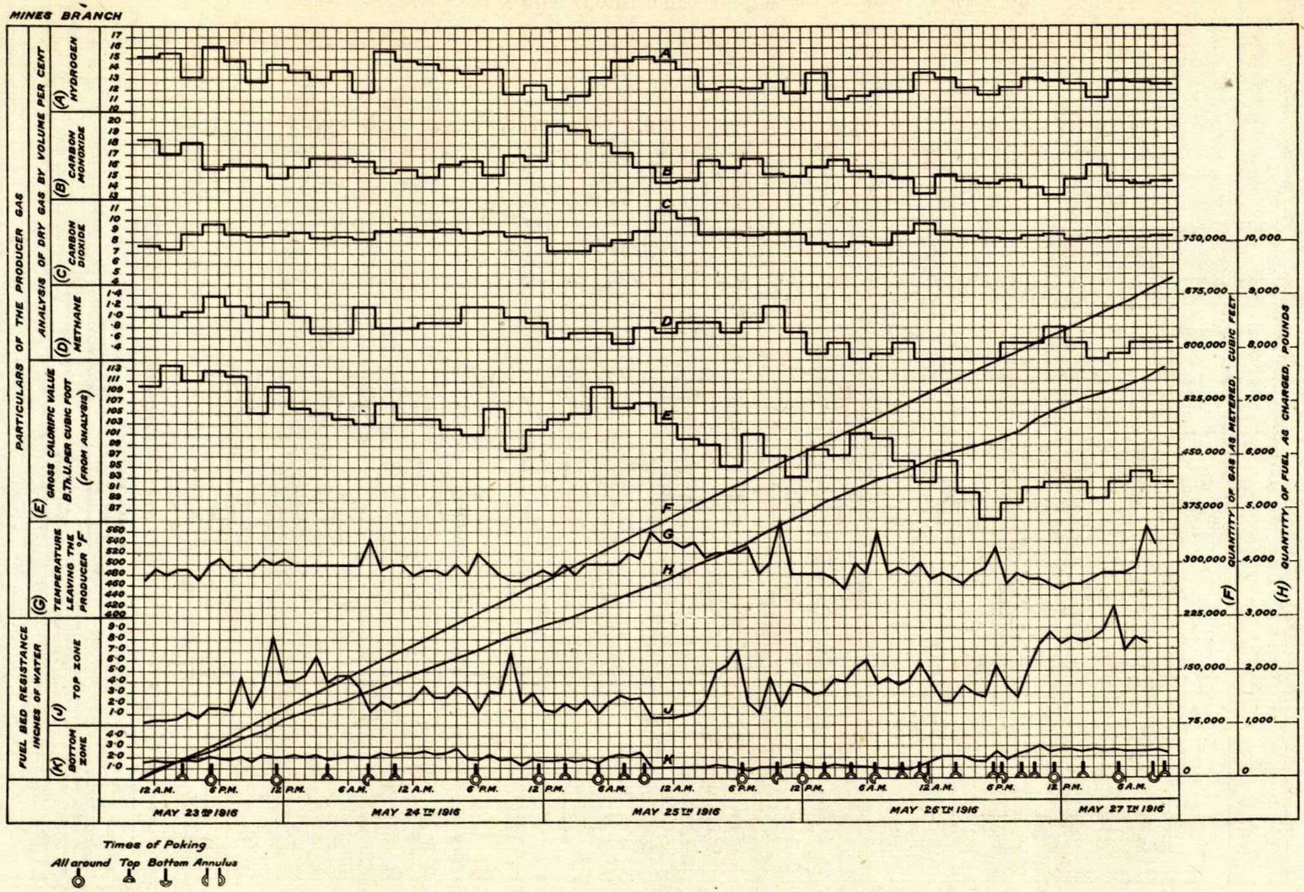

Chart No. 13. Trial No. 97: Fuel—"Greenhill," West Canadian Collieries, Ltd.

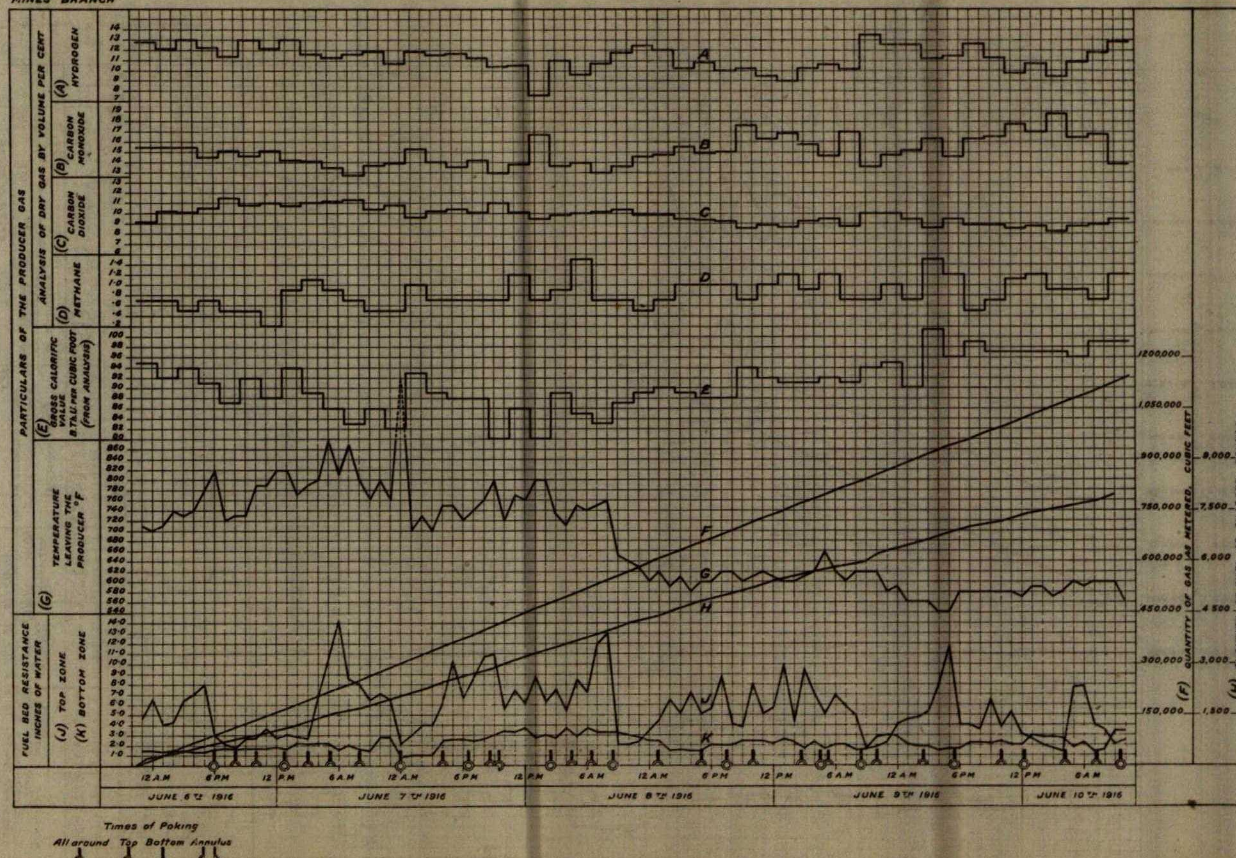

Chart No. 14. Trial No. 90. Fuel—"Greenhill," West Canadian Collieries, Ltd.

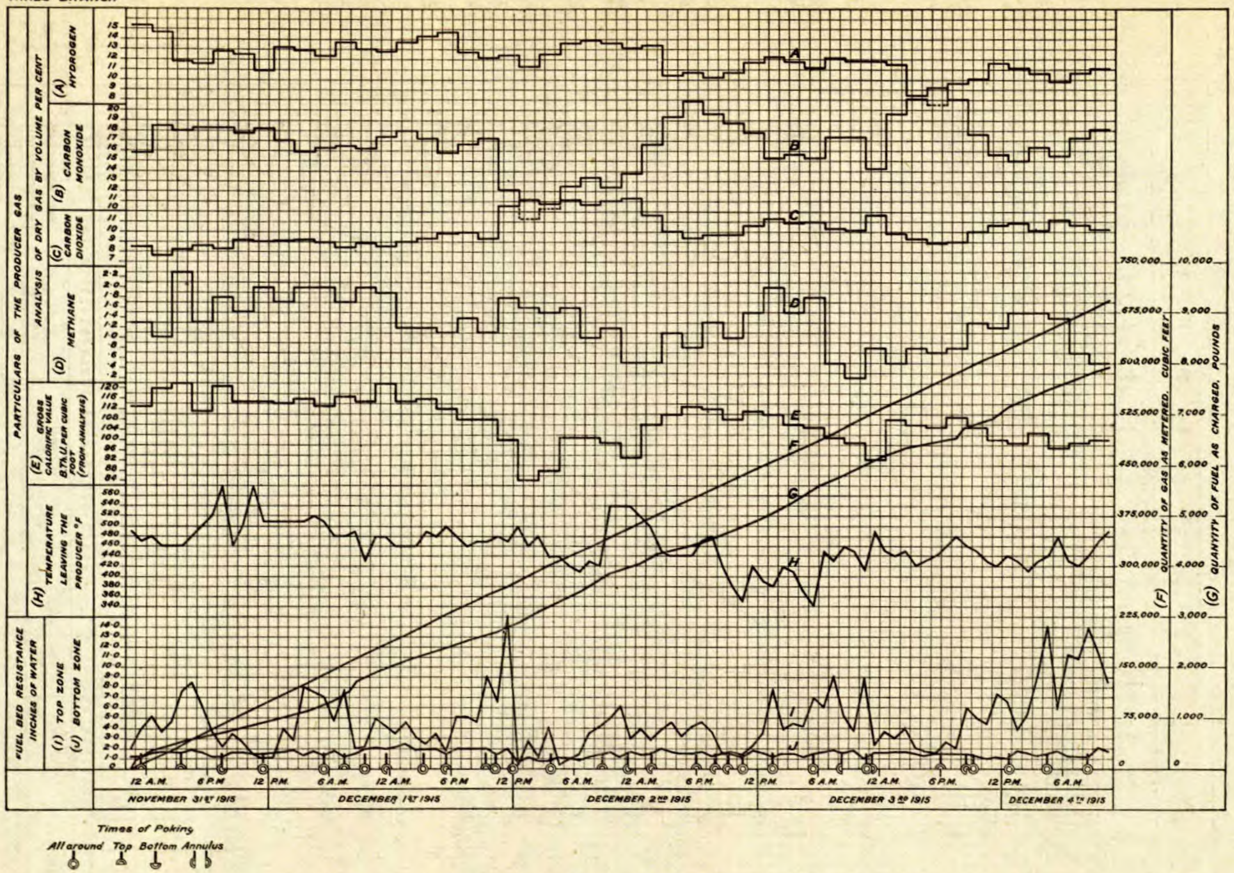

Chart No. 15. Trial No. 86: Fuel—Franco-Canadian Collieries, Ltd.

MINES BRANCH

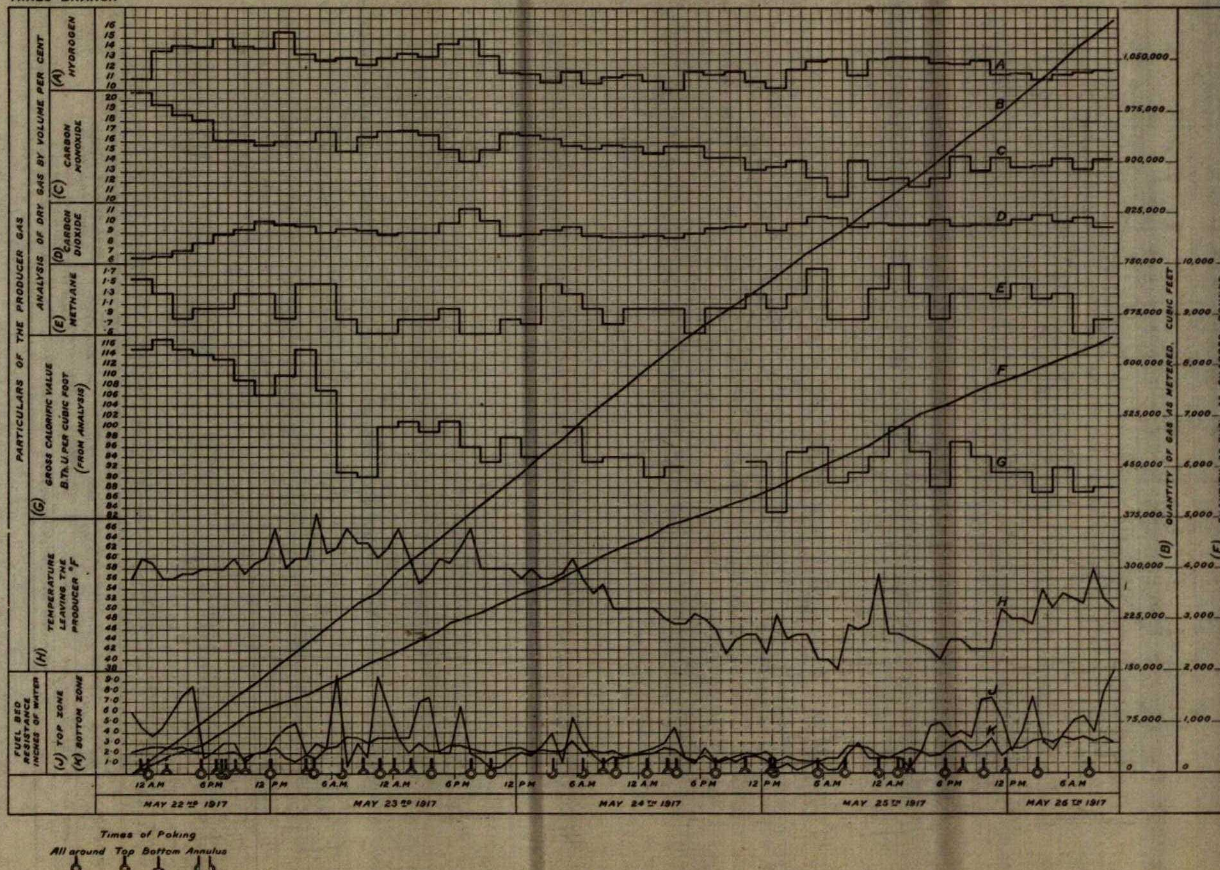

Chart No. 16. Trial No. 116: Fuel—Hillcrest Collieries, Ltd.

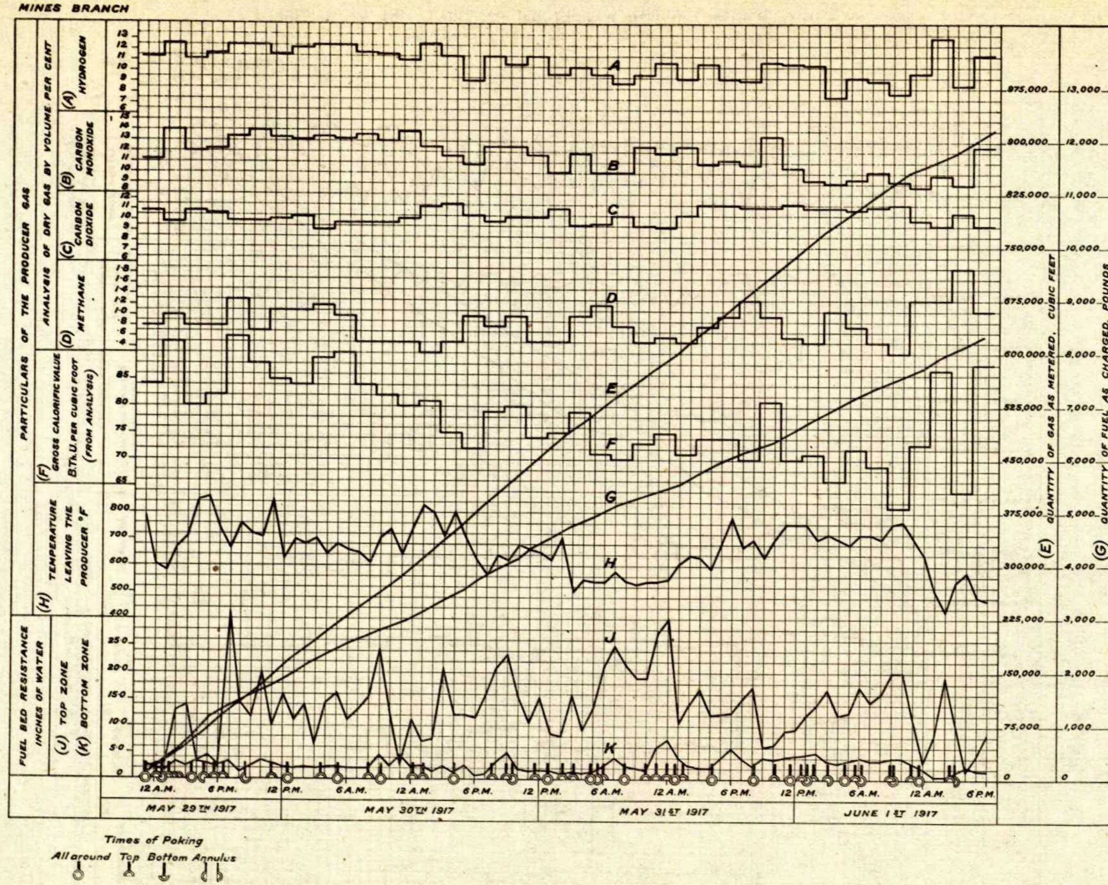

Chart No. 17. Trial No. 117: Fuel—Hillcrest Collieries, Ltd.

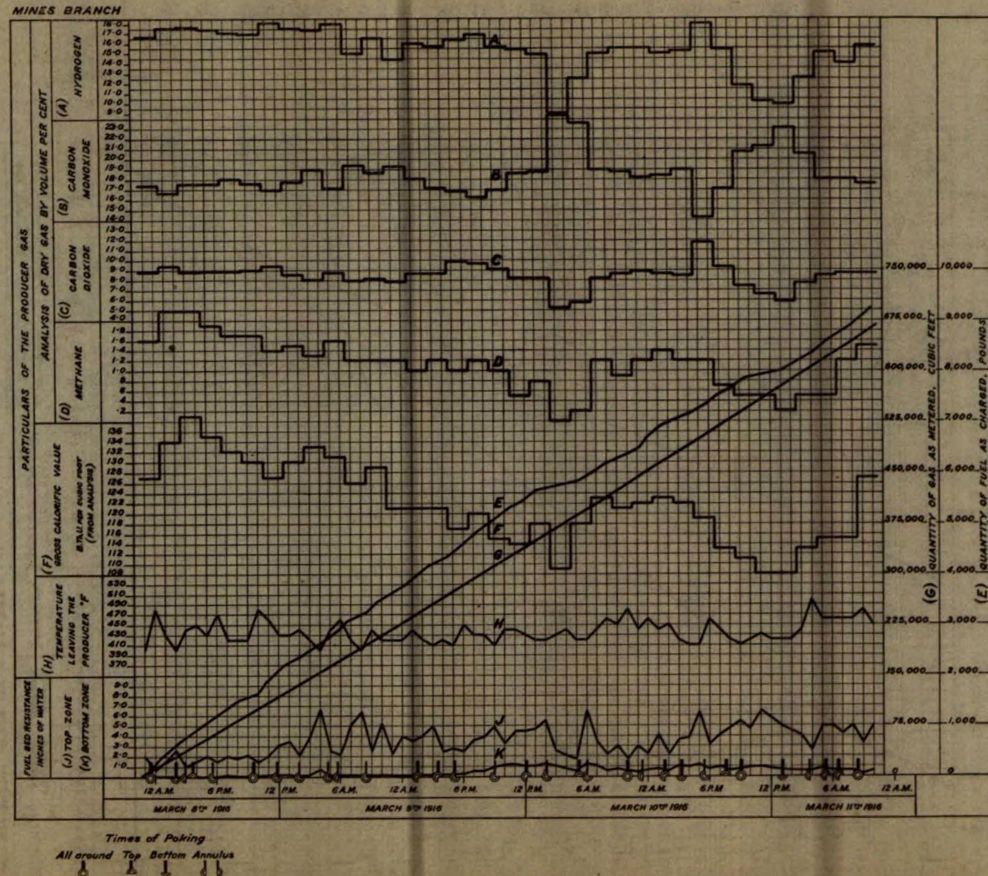

Chart No. 18. Trial No. 92: Fuel—Chinook Coal Co., Ltd.