

CANADA
DEPARTMENT OF MINES
HON. CHARLES STEWAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER.

MINES BRANCH

JOHN McLEISH, DIRECTOR.

INVESTIGATIONS IN 1920

FUELS AND FUEL TESTING

(Testing and Research Laboratories)

- (a) General Review of Investigations: by B. F. Haanel.
- (b) Carbonization of Peat: by E. Stansfield and J. H. H. Nicolls.
- (c) Notes on the Hoffmann Potash Test: by J. H. H. Nicolls.
- (d) Trent Process for purifying coal high in ash: by B. F. Haanel.
- (e) Preliminary report on the investigation of the manufacture of peat fuel, conducted by the Joint Peat Committee of the Federal Government and the Government of Ontario, up to December 31, 1920; together with a statement of the plans, and outline of the work to be done during the year 1921: by B. F. Haanel.

(Annual Summary Report of the Mines Branch, pp. 39-54, and 76-81)



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FUELS AND FUEL TESTING DIVISION

I

GENERAL REVIEW OF INVESTIGATIONS

B. F. Haanel

Chief of Division

The Fuels and Fuel Testing Division has been engaged during the fiscal year 1919-20, on research work which has been in progress for some years, the results of which are not yet ready for publication; also on certain investigations, the results of some of which are sufficiently far advanced for publication in preliminary form. The research work on oil-shales, lignitic coal, and peat, will, it is hoped, be ready for publication at the end of 1921. The determinations of oil in the several samples of oil-shales submitted to the laboratory for investigation, by Dr. W. J. Wright—who, before he severed his connexion with the Department of Mines, was engaged in investigating the oil-shale formations of New Brunswick, Nova Scotia, and elsewhere—are not yet complete.

The report on the special investigations of lignites, conducted by the staff of the Fuels and Fuel Testing Division, in co-operation with the Lignite Utilization Board, which were begun by Edgar Stansfield and R. E. Gilmore, in 1919, is in course of preparation by Mr. Stansfield, and will, it is hoped, be published in the near future.

II

CARBONIZATION OF PEAT

Edgar Stansfield and J. H. H. Nicolls

In conjunction with the small scale carbonization experiments on samples of lignite from Saskatchewan and Alberta¹, a similar series was carried out on peat from the bog at Alfred, Ontario. The finely ground peat was moulded, in a hand press, into cylindrical briquettes, $\frac{1}{4}$ -inch diameter and about $\frac{1}{4}$ -inch long, which ran about 6 or 8 to the gram. These were stored in glass stoppered bottles, under which conditions the moisture was found to remain almost unchanged for a period of four or five weeks. The moisture content, 25 per cent, represents the average moisture content of peat as it comes on the market.

The apparatus employed was similar to that described on page 90 of the Summary Report¹ for 1918, an excerpt from which follows:—

“The apparatus used in the experiments consisted of a cylindrical iron retort $1\frac{1}{2}$ inch high and $1\frac{1}{2}$ inch diameter, inside measurement, having a lid which was held on by a small clamp, the joint being rendered air-tight by means of an asbestos gasket. A small inlet tube was screwed into the bottom of the retort, and an outlet tube into the lid; the inlet and outlet tubes being so arranged that the retort could be completely immersed in an oil or lead bath.

“The briquettes employed in each test were weighed out into a 10-gram capacity quartz crucible which fitted inside the iron retort. The heating was done by immersing the retort in a bath, which for tests up to 300° C. was of oil, and for those above that temperature of lead. The lead was contained in a 4-inch length of 4-inch iron pipe with a cap end, and was heated in a gas-fired furnace which gave a very uniform temperature throughout the bath, and which permitted of rapid heating and easy control. The temperature was followed by pyrometers immersed in the lead.

¹ Mines Branch Summary Reports—1918, p. 90—1919, p. 30.

"Procedure.—The general procedure, modified in the particular cases noted, was as follows. From 3 to 10 grams of the briquetted sample was weighed out into the quartz crucible, this was placed in the iron retort and the top clamped down. A gentle stream of dry coal gas was passed in through the inlet tube to displace the air, the gas was then cut off and the retort immersed in the bath of oil or lead, previously heated to almost the desired temperature. The progress of carbonization was watched by causing the evolved gas to bubble through a little water; it was thus found that 1½ hour was sufficient to complete the operation. In every case after the lead bath had been finally adjusted to the desired temperature, this temperature was maintained for at least half an hour. At the end of the experiment the retort was taken out of the bath and cooled as rapidly as possible, cold water being run over it to complete the cooling. When quite cold the retort was opened and the quartz crucible weighed to determine the loss in weight of the briquettes during the experiment. The calorific value of the carbonized briquettes was then determined by means of a Riche adiabatic calorimeter using a platinum resistance thermometer. Ash and volatile matter determinations were also made.

"It was found necessary to standardize the conditions, especially the time factor, in all operations with the dried or carbonized residue. The quartz crucible and contents were always weighed in a stoppered weighing bottle, and the portion required for the calorimeter was weighed out by difference as nearly as possible fifteen minutes after stopping the heating."

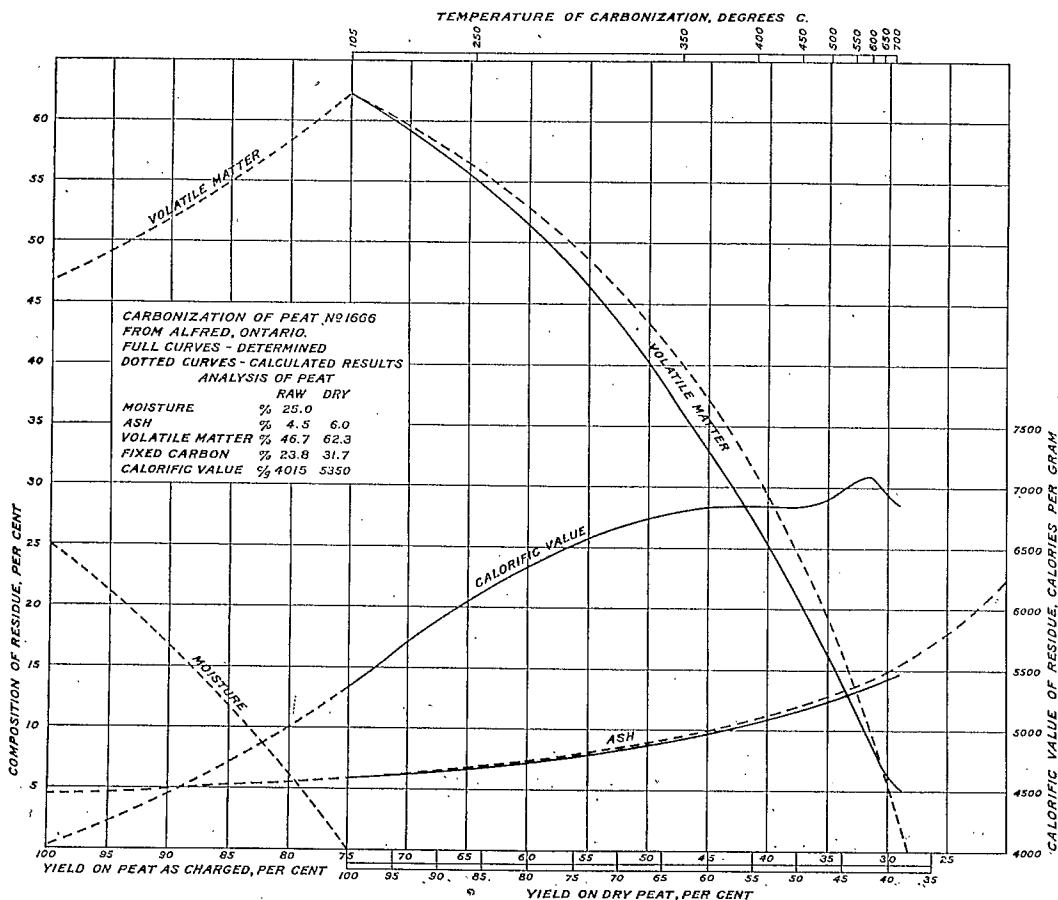


Fig. 2

The results of the experiments are shown graphically in Fig. 2, while Table I, which is derived from the rounded curves in the diagram, indicates the results obtainable from the carbonization of dry peat.

It will be observed that the calorific value rises very greatly with the temperature of carbonization, the maximum percentage increase being 32.5, at 600°, as against an increase of 20.5 in the case of Shand lignite, these values having been calculated on the basis of the dried fuel. This increased calorific value is obtained only after 58 per cent of the dry, or 68 per cent of the raw peat has been driven off, so that, at least without a high yield of valuable by-products, the distillation would be inefficient.

However, the calorific value of peat increases rapidly at temperatures below 350°, a large amount of volatile incombustible matter being driven off, in which respect it differs materially from the lignites so far examined. From 375° to 450° the calorific value remains practically constant, so that carbonization at 400°, with a yield of 55 per cent (or 41 per cent from the raw peat), and a percentage increase in calorific value of 27.9, would probably be more efficient than at 600°. To illustrate this, and in order to compare the products of carbonization of peat with those obtained from lignite, Table II has been drawn up.

In view of the exceptionally high percentage of distillates, it is obvious that a study of the carbonization of peat is incomplete without the determination of the by-products. Accordingly, a series of large scale laboratory experiments¹ will shortly be carried out on the carbonization of peat and of certain of the Alberta lignites. This will presumably be followed by still larger scale experiments, in order to obtain the most complete information possible.

TABLE I

| Temperature of carbonization, degrees C. | Yield of residue | Analysis of residue | | | |
|--|------------------|------------------------------------|-------|-----------------|--------------|
| | | Calorific value, calories per gram | Ash | Volatile matter | Fixed carbon |
| 105°..... | 100.0% | 5350 | 6.0% | 62.3% | 31.7% |
| 250°..... | 86.0% | 6090 | 6.7% | 55.1% | 38.2% |
| 280°..... | 77.8% | 6400 | 7.3% | 49.9% | 42.8% |
| 350°..... | 63.3% | 6800 | 9.2% | 36.3% | 54.5% |
| 400°..... | 54.9% | 6840 | 10.7% | 26.7% | 62.6% |
| 450°..... | 49.7% | 6850 | 11.6% | 20.0% | 68.4% |
| 500°..... | 46.3% | 6910 | 12.5% | 15.8% | 71.7% |
| 550°..... | 44.0% | 7030 | 13.1% | 12.3% | 74.6% |
| 600°..... | 42.1% | 7090 | 13.6% | 9.7% | 76.7% |
| 650°..... | 40.6% | 6990 | 14.0% | 7.0% | 79.0% |
| 700°..... | 39.3% | 6900 | 14.4% | 5.6% | 80.0% |

¹ Summary Report, 1913, p. 99.

TABLE II

| Fuel | C.V. of dry coal, calories per gram | Yield* at 400°C. | C.V. of residue at 400°C. | Percentage increase C.V. at 400°C. | Optimum ¹ temperature degrees C. | Yield* at op. temp. | C.V. of residue at op. temp. | Percentage increase C.V. at op. temp. |
|--|-------------------------------------|------------------|---------------------------|------------------------------------|---|---------------------|------------------------------|---------------------------------------|
| Alfred peat..... | 5350 | 55% | 6840 | 27.9 | 600° | 42% | 7090 | 32.5 |
| Saskatchewan Coal, Brick and Power Co., Shand, Sask..... | 6250 | 80% | 7120 | 13.9 | 570° | 66% | 7530 | 20.5 |
| West Dominion Collieries, Taylorton, Sask..... | 6050 | 79% | 6650 | 9.9 | 580° | 68% | 7050 | 16.5 |
| Cardiff Collieries, Ltd., Cardiff, Alta..... | 6100 | 83% | 6700 | 9.8 | 620° | 67% | 7130 | 16.9 |
| G. W. Coal Co's. Black Diamond mine, Clover Bar, Alta..... | 6390 | 83% | 6970 | 9.1 | 600° | 67% | 7470 | 16.9 |
| Tofield Coal Co's. mine, Tofield, Alta..... | 6480 | 84% | 6960 | 7.4 | 600° | 67% | 7460 | 15.1 |
| Halbert's mine, Trochu, Alta..... | 6430 | 84% | 6730 | 4.7 | 630° | 71% | 7170 | 11.5 |

*Yields indicated are those from dried fuel.

¹ Temperature at which highest calorific value is obtained.

III NOTES ON THE HOFFMANN POTASH TEST

J. H. H. Nicolls

A previous report,¹ described the application of the Hoffmann Potash Test to the classification of coals. It was shown that the usual test with boiling potash solution, whilst providing a broad general classification, made insufficient distinction between the various lower grade coals and lignites. The cold test, on the other hand, made a distinction, but required too much time for practical purposes.

The writer recently attempted to work out a modified test, which would further differentiate between the various lower grade coals. The following methods were tried: (1) dilution of the solution, obtained by boiling $\frac{1}{2}$ gram of coal with the standard potash solution (as in the general test), with definite volumes of water; (2) boiling $\frac{1}{2}$ gram of coal with standard potash solution diluted with one or more volumes of water; (3) boiling $\frac{1}{10}$ gram of coal with standard potash; (4) boiling $\frac{1}{10}$ gram of coal with standard potash diluted with one or more volumes of water; and (5) determining what dilution of standard potash solution was necessary, in order to produce a certain definite colour, on boiling with a particular coal.

Each of these methods indicated distinct differences between the low grade coals, but unfortunately the results obtained by one method did not always place the coals in the same order as did those from another. It was also observed that the effect of the potash upon two samples from the same locality were sometimes markedly different. Contrary to expectation, it was found that dilution of the potash, up to a certain limit, increased its action on the coal. The accompanying table shows that the results obtained by boiling $\frac{1}{10}$ gram of coal with the standard solution proved the most satisfactory.

In referring to the table it should be noted that (1) all the coals with the exception of the Shand are from Alberta; (2) the moisture on the Shand coal, air dried, is the average obtained from the analyses of several samples from the same locality, the "split volatile" ratio being derived from an analysis calculated on the basis of this moisture, while the carbon-hydrogen ratio is from the analysis of a sample taken from the Shand mine at almost the same time as No. 973; (3) Dowling's "split volatile" ratio is "fixed carbon + $\frac{1}{2}$ volatile matter," divided by "moisture + $\frac{1}{2}$ volatile matter"; and (4) "1:0" indicates standard potash solution, sp. gr. 1.12, and "1:4", "1:50", indicate standard potash diluted with 4 and 50 volumes, respectively, of water.

It was observed that, in the case of certain of the more dilute solutions which filtered slowly, the filtrate which passed through the paper after the potash had been in contact with it for 15 or 20 minutes, contained a cloud of fine black particles, and that a small quantity of these particles was sufficient to obscure the brown colour of the bulk of the filtrate. This suggested that the potash, being longer than usual in contact with coal, attacked it more than in the usual test, or that it attacked the paper and allowed very fine particles of coal to pass through it.

The second of these hypotheses seemed the more likely, and this further suggested that a certain amount of colour might be produced when the potash attacked the paper. Accordingly, several kinds of filter paper were boiled with both strong and dilute potash solution, with resultant yellow colours. In most cases these were not dark enough to have any effect on the colours from the lower grade coals, but would probably obscure those from the high grade ones. Care should, therefore, be taken in the choice of filter paper. Furthermore, when dilute solutions are employed, only the filtrate which passes through the paper during the first 15 minutes of filtering (in most cases this is fully three-quarters of the filtrate) should be considered.

Certain points in the former paper may perhaps be a little indefinite. In the first place, by "ferric chloride" is meant by hydrated salt with 6 molecules of water. In the second place, it should be distinctly understood that the undiluted solution of ferric chloride, etc., is No. 1 of the Hoffmann series.

¹ Mines Branch Summary Report, 1916, p. 65.
36404-2½

TABLE I

| Sample number | Locality | Calories per gram, ash and moisture free coal | Moisture, air dried coal | Carbon-hydrogen ratio, air dried coal | Fuel ratio | "Split volatile" ratio, air dried coal. | Boiling with "1.0", original series | "Cold test" with "1.0" | "Boiling with "1.0", recent series | Filtrate from last test with 90 vols. water | Boiling with "1.50" | 1-10 gr. boiling with "1.0" | 1-10 gr. boiling with "1.4" | 1-10 gr. boiling with "1.50" |
|---------------|---------------------|---|--------------------------|---------------------------------------|------------|---|-------------------------------------|------------------------|------------------------------------|---|---------------------|-----------------------------|-----------------------------|------------------------------|
| 720 | Saunders Creek..... | 7470 | 8.5 | 13.4 | 2.05 | 3.2 | (4-5) | 7 | (5-4) | 8 | | (7-6) | | |
| 321 | Lethbridge..... | 7440 | 8.8 | 11.8 | 1.40 | 2.5 | 3 | (6-5) | | | | 6 | | |
| 306 | "..... | 7510 | 8.9 | 11.6 | 1.40 | 2.5 | (3-2) | | | | | (5-6) | | |
| 722 | "..... | 7250 | 9.3 | 11.5 | 1.80 | 2.7 | (3-2) | | (3-4) | (7-8) | 5 | (5-6) | | |
| 406 | Taber..... | 7230 | 14.0 | 10.5 | 1.45 | 2.1 | (1-2) | 4 | | | | (3-4) | | |
| 407 | "..... | 7010 | 12.4 | 10.6 | 1.55 | 2.2 | (1-2) | | | | | (3-4) | | |
| 682 | Cardiff..... | 6700 | 18.9 | 9.3 | 1.50 | 1.7 | (1-2) | 4 | | | | (3-4) | | |
| 353 | Evansburg..... | 6750 | | | 1.60 | | | | 1 | (5-6) | (3-3) | (4-3) | (3-2) | (3-4) |
| 916 | Hanna..... | 6760 | 21.2 | 8.9 | 1.35 | 1.5 | 1 | | 1 | (5-4) | (2-1) | (3-2) | (2-1) | (2-3) |
| 665 | Rosedale..... | 7250 | 13.9 | 11.3 | 1.40 | 2.1 | 1 | (4-3) | 1 | (5-6) | (3-2) | 3 | (2-3) | (4-3) |
| 1505 | Edmonton..... | 6890 | | | 1.50 | | | | 1 | (5-6) | 3 | 3 | (2-3) | (3-4) |
| 680 | "..... | 6810 | 17.3 | 10.3 | 1.70 | 2.0 | 1 | 3 | | | | (3-2) | | (3-2) |
| 1507 | Tofield..... | 7000 | | | 1.35 | | | | (1-2) | 6 | (3-2) | 4 | 3 | 4 |
| 180 | "..... | 6930 | 15.9 | 10.1 | 1.30 | 1.9 | 1 | (3-2) | 1 | | | (2-3) | | (2-1) |
| 973 | Shand..... | 6760 | 27.0 | 7.9 | 1.20 | 1.2 | | | 1 | (5-4) | 1 | (2-3) | 1 | 1 |

IV

TRENT PROCESS FOR PURIFYING COAL HIGH IN ASH

B. F. Haanel

On November 25, 1920, the writer visited the experimental plant of the Trent Process Corporation, Washington, D.C., U.S.A., to witness the tests which were being conducted, according to their process, on several samples of Canadian coals, high in ash. The experimental laboratories of the Trent Process Corporation are located on ground adjacent to the United States Bureau of Standards, which Bureau, the writer was informed, co-operated with this Corporation in conducting certain investigations.

DESCRIPTION OF PROCESS

The reduction of the ash content of a coal high in ash, depends upon the selective affinity of oil for the carbonaceous matter in coal, and of water for the mineral ash content. In order to obtain a good separation of the mineral matter of the coal, and at the same time a complete agglomeration of the carbon matter with the oil, it is necessary to crush the coal to about 200 mesh. Coal of this fineness mixed with a large amount of water, is placed in a churn, similar to a churn for making butter, in which it is thoroughly agitated, oil being slowly admitted during the period of agitation. The quantity of oil required, while not the same for every coal, is in the neighbourhood of 40 to 45 per cent by weight, of the coal treated. When the mixture of oil, water, and finely divided coal, is briskly agitated, the oil and the carbon begin to agglomerate, and the ash settles in the water. When the action is complete, a separation of the oil and carbon, in small globules, and the water containing the mineral ash content, is very marked. The time required for making the separation varies with different coals. With certain of the coals treated, the time required did not exceed two to three minutes; while with other coals fifteen or more minutes were required to obtain a complete separation. In the case of lignites, however, the time required to obtain an agglomeration of the carbon and oil has been as long as 9 hours; for example, the time required to obtain an agglomeration of the carbon and oil of a sample of lignite from North Dakota was nine hours. Complete agglomeration, however, was obtained in a much shorter time with a sample of lignite from the Shand mine, Saskatchewan, namely, 25 minutes. The details of this test will be found on page 51. The tests on the samples of coal which the writer had sent to the Trent Process Corporation laboratories, from British Columbia, Alberta, Saskatchewan, and Nova Scotia, were conducted in small laboratory apparatus, and not in their large semi-commercial plant. Such separations as were made at Washington, can be made in any laboratory, by simply putting the pulverized coal, water, and oil, in a small butter churn, or a large size churn for whipping cream. This latter is usually made of glass, and would permit the agglomeration of the oil and the separation of ash to be seen. While the writer was in their laboratories, he witnessed large samples of coal being treated in a semi-commercial plant. This plant consists of a specially designed mill for pulverizing the coal to 200-mesh, and an agitator, or as it is called at the plant, an "amalgamator," of large size, into which the pulverized coal and oil are automatically fed. The specially designed pulverizing mill employed at this plant, and which will be employed in the commercial plants the Trent Process Corporation contemplate erecting, consists of seven horizontal steel cylinders, Fig. 3, bound together by iron hoops, and into which tubes, as shown in Fig. 4, are placed. The coal is pulverized in the presence of water, by the grinding action of the tubes and of the tubes on the walls of the chambers, when the mill is rotated. The mill in the Washington laboratories was composed of seven of these cylinders, and a large

number of tubes, as shown: the tubes in the central cylinder or chamber being larger than the tubes in the other six chambers. Coal and water are fed into these chambers through a curved pipe rotating with the mill, and which dips into a chamber filled with crushed coal and water at every revolution. A section of the feeding device is shown in Fig. 5. The pulverized coal is discharged through the opposite end.

It would appear that the loss in iron due to the abrasion of these pipes on each other, and on the walls of the containing chambers, would be considerable; but the writer was informed that this appeared to be comparatively small, and that ordinary iron pipes proved to be more economical in this respect than pipes made of a specially hard steel. The agitator or amalgamator, as it is called, is shown in Figures 6 and 7. Fig. 6 represents a vertical section through the centre, and shows the arrangement of the paddles, the oil feeds, admission for the pulverized coal and water, and also the discharge. Fig. 7 is a top view of the amalgamator. This apparatus does not require detailed description inasmuch as the drawings are self explanatory.

Finished Product.—When the separation is complete, the mixture consists of an agglomeration of the oil and carbon with a small amount of ash, and the water in which the larger portion of the mineral is contained. For making a separation, gasoline, kerosene, light oils, or fuel oils may be used. The oil commonly used, however, is "navy fuel oil," and the amount required, as stated before, varies with the coal treated, and is from 40 to 45 per cent by weight of the fuel treated.

The Trent Process Corporation advocate the burning of this amalgam directly under steam boilers, and at the time of the writer's visit they were experimenting with different methods for conveying the fuel from the plant to boilers which were situated in the boiler house of the Bureau of Standards, and also with various hearths oil which the amalgam could be burned successfully. It must be understood, however, that while this amalgam possesses some of the properties of what is known as a colloidal fuel, it is, strictly speaking, not a colloid, since in the latter the carbon matter is held in suspension in the oil, and the mixture of oil and carbon matter known as colloidal fuel can be transmitted through pipes and burned in oil burners in the same manner as crude oil or fuel oil; while the Trent amalgam, when it reaches the furnace hearth, must be treated more as a solid, and must be burned in somewhat the same manner as a solid fuel.

Recovery of Oil and Briquetting of Purified Coal.—The Trent Process Corporation have also devised a method for retorting this amalgam in order to recover the oils and the volatile matter from the coal. If the coal is a bituminous coal, it leaves a carbonized residue in the retort suitable for briquetting. If the coal pulverized happens to be a coking coal this method for extracting the added oil and the volatile content of the fuel might be successfully employed, since the finely divided fuel, which before treatment had to be ground to 200 mesh, would fuse together. On the other hand, if the fuel treated is a non-coking bituminous coal, the size of the individual particles making up the coal would be, after the completion of the retorting process, much smaller than 200 mesh, and a fuel possessing this degree of fineness cannot be profitably mixed with a binder, and briquetted, on account of the excessive quantity of binder which would be required to cover the enormous surface which the finely divided coal would present.

The efficiency of the ash separation depends very largely on the fineness to which the coal is pulverized, and it will, therefore, be readily seen that, if coarser grinding is resorted to, the ash reduction will be notably less.

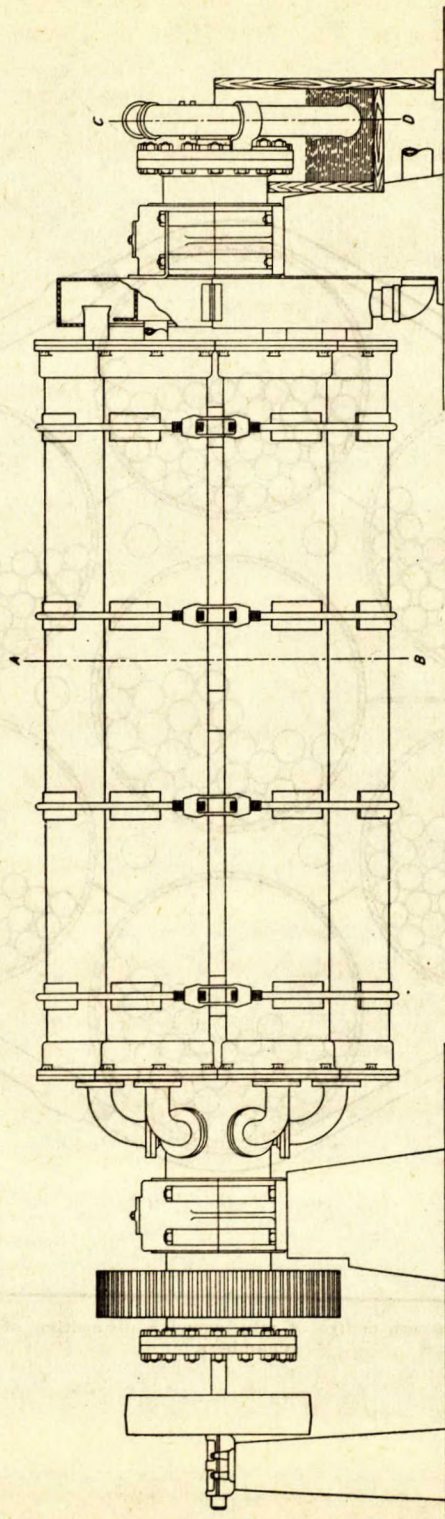


Fig. 3. Longitudinal elevation of pulverizer.

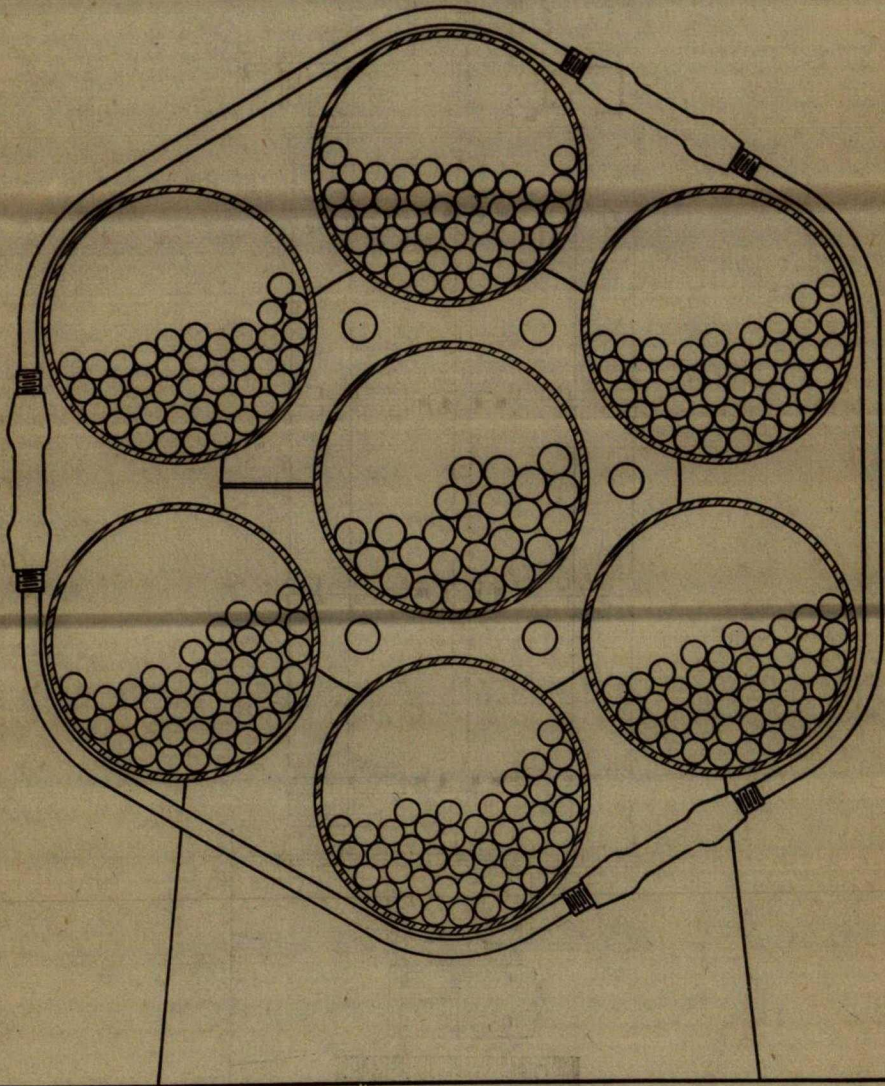


Fig. 4. Section A-B through centre of mill, showing disposition of tubes in cylindrical chambers.

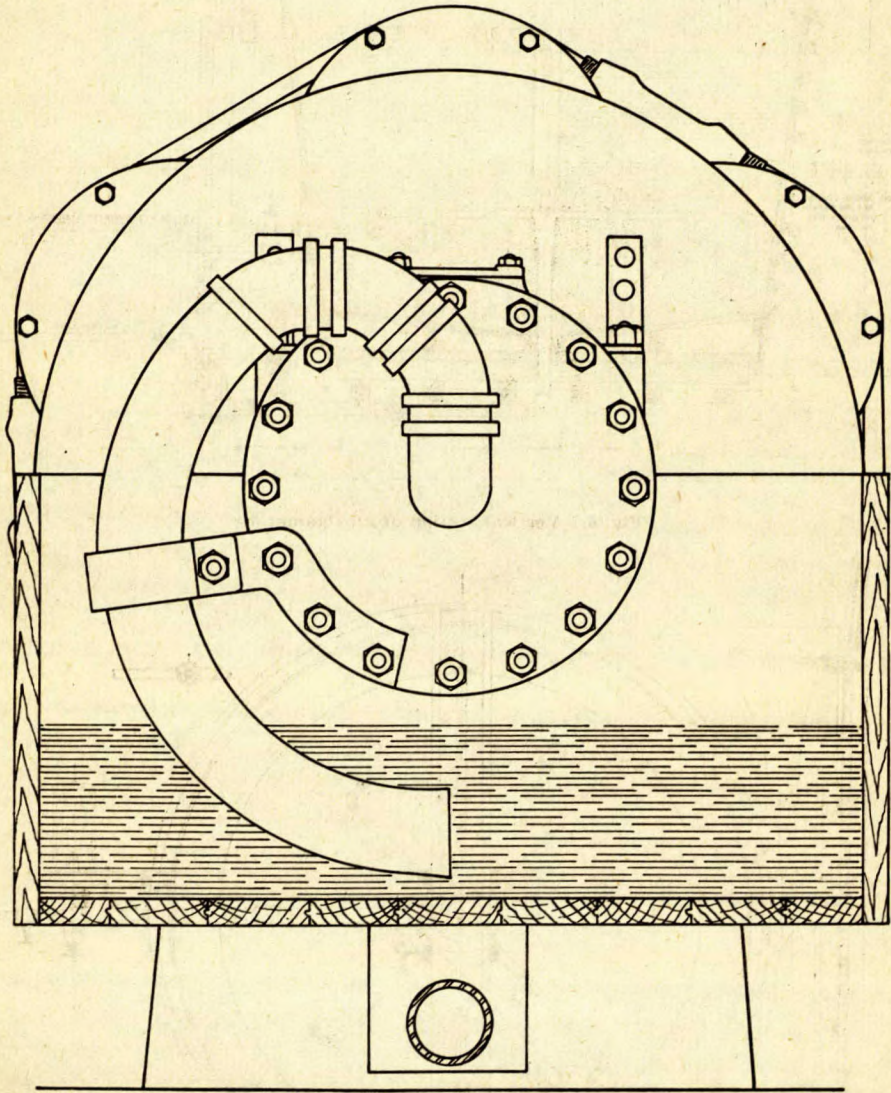


Fig. 5. Section C-D through feeder showing method of feeding coal to pulverizing chambers.

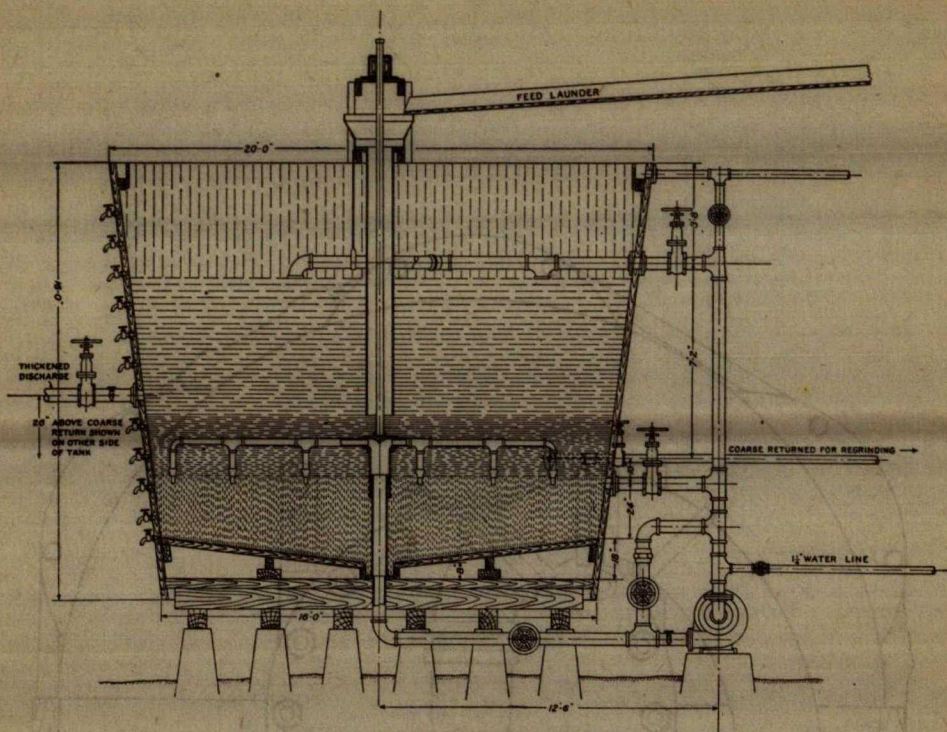


Fig. 6. Vertical section of amalgamator.

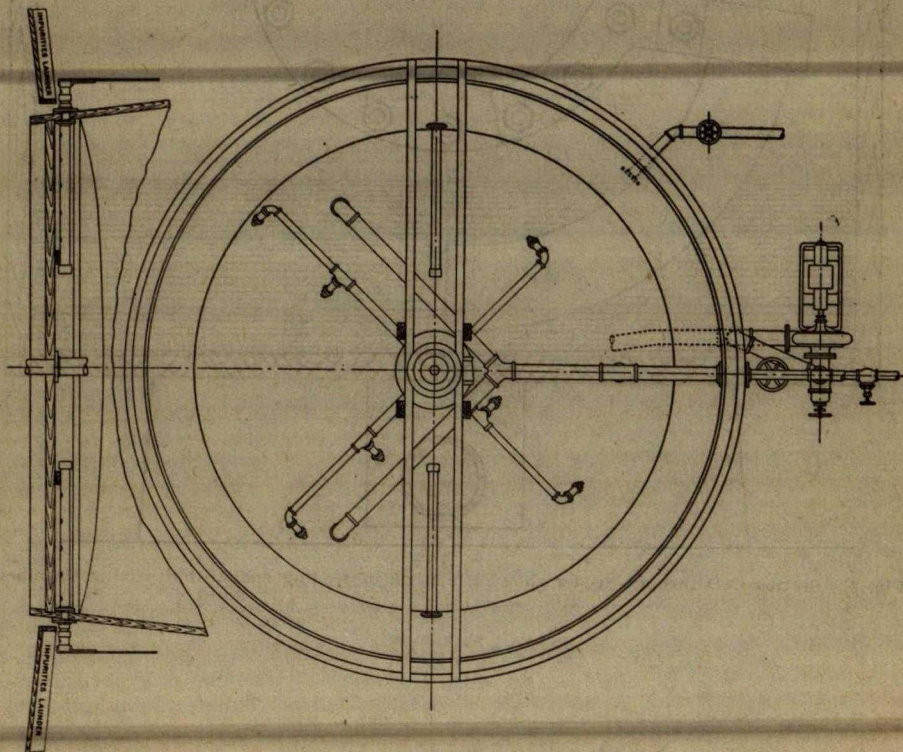


Fig. 7. Top view of amalgamator.

SAMPLES OF COAL SENT FOR PURIFICATION TO THE TRENT PROCESS CORPORATION LABORATORIES, WASHINGTON, D.C., U.S.A.

The following samples of coal were obtained through the courtesy of the Provincial Mineralogist, British Columbia, and the Chief Inspector of Mines of Alberta and Nova Scotia:—

Nova Scotia—

- 1—Greenwood Coal Co., No. 2, Bal. No. 2, East Landing, 6 pounds.
- 2—Greenwood Coal Co., No. 1, West, 6 pounds.
- 3—Greenwood Coal Co., No. 3, left of slope, east side, 2 pounds.
- 4—Greenwood Coal Co., No. 1, Bal. No. 2, West, 2 pounds.
- 5—Greenwood Coal Co., No. 3, left, west side of slope, 2 pounds.
- 6—Greenwood Coal Co., Tar King coal, 2 pounds.

Alberta—

- 1—Maple Leaf Mine No. 133, operated by the Bellevue Collieries, Bellevue, Alberta, 4 pounds.

British Columbia—

- 1—No. 5 mine, lump coal, Canadian Collieries (Dunsmuir), Union Bay, B.C.

Saskatchewan—

- 1—Sample of lignite sent from the Fuel Testing Station, Ottawa, which was obtained from the Shand mine, Southern Saskatchewan.

RESULTS OF TESTS

Lignite: from Shand Mine, Southern Saskatchewan

| Description | Moisture | Volatile | Fixed carbon | Ash | Original ash removed | Original carbon recovered |
|-----------------------------------|----------|----------|--------------|-------|----------------------|---------------------------|
| | % | % | % | % | % | % |
| As received..... | 16.45 | 29.92 | 38.72 | 14.91 | | |
| Moisture free..... | | 35.52 | 45.92 | 18.56 | | |
| Navy fuel amalgam..... | | | | 4.95 | | |
| Dry purified coal..... | | | | 7.47 | 64 | |
| Coke or carbon from original..... | | | 71.18 | 28.82 | | |
| “ “ purified..... | | | 76.31 | 23.69 | | |

Per cent of navy fuel oil required (by weight) 44%. Specific gravity .86.

Coal: from Greenwood Coal Co., No. 2, Bal. No. 2, East Landing

| | | | | | | |
|-----------------------------------|------|-------|-------|-------|----|----|
| As received..... | 3.14 | 22.37 | 59.00 | 15.49 | | |
| Moisture free..... | | 23.41 | 60.41 | 16.18 | | |
| Navy fuel amalgam..... | | | | 3.56 | | 98 |
| Dry purified coal..... | | | | 5.34 | 72 | 98 |
| Coke or carbon from original..... | | | 78.88 | 21.12 | | 98 |
| “ “ purified..... | | | 89.55 | 10.45 | 58 | 98 |
| Residue from wash water..... | | | 14.92 | 85.08 | 72 | 98 |

Per cent of navy fuel oil required (by weight) 43%. Specific gravity .86.

Coal: from Greenwood Coal Co., No. 1, west

| Description | Moisture | Volatile | Fixed carbon | Ash | Original ash removed | Original carbon recovered |
|-----------------------------------|----------|----------|--------------|-------|----------------------|---------------------------|
| | % | % | % | % | % | % |
| As received..... | 2.93 | 22.57 | 54.51 | 19.99 | | |
| Moisture free..... | | 23.42 | 56.05 | 20.53 | | |
| Navy fuel amalgam..... | | | | 6.00 | | 98 |
| Dry purified coal..... | | | | 9.00 | 62 | 98 |
| Coke or carbon from original..... | | | 73.23 | 26.77 | | 98 |
| “ “ purified..... | | | 84.78 | 15.22 | 53 | 98 |
| Residue from wash water..... | | | 19.00 | 81.00 | 62 | 98 |

Per cent of navy fuel oil required (by weight) 42%. Specific gravity .86.

Coal: from Greenwood Coal Co., No. 3, left of slope, east side

| | | | | | | |
|-----------------------------------|------|-------|-------|-------|----|----|
| As received..... | 2.70 | 23.30 | 57.08 | 16.92 | | |
| Moisture free..... | | 24.02 | 58.07 | 17.31 | | |
| Navy fuel amalgam..... | | | | 4.50 | | 99 |
| Dry purified coal..... | | | | 6.75 | 79 | 99 |
| Coke or carbon from original..... | | | 77.24 | 22.76 | | 99 |
| “ “ purified..... | | | 88.38 | 11.62 | 59 | 99 |
| Residue from wash water..... | | | 12.05 | 87.95 | 79 | 99 |

Per cent of navy fuel oil required (by weight) 43%. Specific gravity .86.

Coal: from Greenwood Coal Co., No. 1, Bal. No. 2, west

| | | | | | | |
|-----------------------------------|------|-------|-------|-------|----|------|
| As received..... | 3.38 | 21.41 | 59.51 | 15.70 | | |
| Moisture free..... | | 22.32 | 61.47 | 16.21 | | |
| Navy fuel amalgam..... | | | | 4.88 | | |
| Dry purified coal..... | | | | 7.32 | 60 | 98.5 |
| Coke or carbon from original..... | | | 79.12 | 20.88 | | |
| “ “ purified..... | | | 87.58 | 12.42 | 48 | |
| Residue from wash water..... | | | 17.82 | 82.18 | 60 | 98.5 |

Per cent of navy fuel oil required (by weight) 43%. Specific gravity .86.

Coal: from Greenwood Coal Co., No. 3, left, west side of slope

| | | | | | | |
|-----------------------------------|------|-------|-------|-------|----|------|
| As received..... | 2.35 | 22.61 | 58.97 | 16.07 | | |
| Moisture free..... | | 23.22 | 60.29 | 16.49 | | |
| Navy fuel amalgam..... | | | | 5.81 | | |
| Dry purified coal..... | | | | 8.71 | 57 | 98.8 |
| Coke or carbon from original..... | | | 78.70 | 21.30 | | |
| “ “ purified..... | | | 86.24 | 13.76 | 38 | |
| Residue from wash water..... | | | 15.05 | 84.95 | 57 | 98.8 |

Per cent of navy fuel oil required (by weight) 43%. Specific gravity .86.

Tar King Coal: from Greenwood Coal Co.

| | | | | | | |
|-----------------------------------|------|-------|-------|-------|----|----|
| As received..... | 2.75 | 20.93 | 53.36 | 22.96 | | |
| Moisture free..... | | 21.42 | 54.94 | 23.64 | | |
| Navy fuel amalgam..... | | | | 6.77 | | 98 |
| Dry purified coal..... | | | | 10.15 | 65 | 98 |
| Coke or carbon from original..... | | | 69.89 | 30.11 | | 98 |
| “ “ purified..... | | | 84.00 | 16.00 | 44 | 98 |
| Residue from wash water..... | | | 13.30 | 86.70 | 65 | 98 |

Per cent of navy fuel oil required (by weight) 40%. Specific gravity .86.

Coal: from Blairmore, Alberta, Canada

| Description | Moisture | Volatile | Fixed carbon | Ash | Original ash removed | Original carbon recovered |
|-----------------------------------|----------|----------|--------------|-------|----------------------|---------------------------|
| | % | % | % | % | % | % |
| As received..... | 50 | 20.44 | 60.05 | 19.01 | | |
| Moisture free..... | | 20.54 | 60.35 | 19.11 | | |
| Navy fuel amalgam..... | | | | 7.50 | | |
| Dry purified coal..... | | | | 11.25 | 47 | 99 |
| Coke or carbon from original..... | | | 75.93 | 24.07 | | |
| “ “ “ purified..... | | | 82.57 | 17.43 | 41 | |
| Residue from wash water..... | | | 9.71 | 90.29 | 47 | 99 |

Per cent of navy fuel oil required (by weight) 42%. Specific gravity .86.

No. 5 Mine lump coal: from Canadian Collieries Co. (Dunsmuir)

| | | | | | | |
|-----------------------------------|-----|-------|-------|-------|----|------|
| As received..... | .65 | 33.89 | 52.61 | 12.85 | | |
| Moisture free..... | | 34.11 | 52.96 | 12.93 | | |
| Navy fuel amalgam..... | | | | 4.00 | | |
| Dry purified coal..... | | | | 6.00 | 57 | 99.5 |
| Coke or carbon from original..... | | | 80.46 | 19.54 | | |
| “ “ “ purified..... | | | 87.50 | 12.50 | 42 | |
| Residue from wash water..... | | | 7.19 | 92.81 | 57 | 99.5 |

Per cent of navy fuel oil required (by weight) 47%. Specific gravity .86.

Comparative Test of Canadian and North Dakota Lignites

| Description | Canadian Lignite from Shand Mine | North Dakota Lignite |
|--|----------------------------------|----------------------|
| | Before Treatment | Before Treatment |
| Moisture..... | 16.45 | 13.85 |
| Volatile..... | 29.92 | 40.23 |
| Fixed carbon in coal as received..... | 38.72 | 32.55 |
| Fixed carbon in coke as received..... | 71.18 | 70.25 |
| Ash in coal as received..... | 14.91 | 13.37 |
| Ash in coke..... | 28.82 | 29.75 |
| Description | After Treatment | After Treatment |
| | | |
| Ash in amalgam..... | 4.98 | 2.52 |
| Ash in dry purified coal..... | 14.29 | 6.53 |
| Ash in coke..... | 23.69 | 15.18 |
| Volatile in dry purified coal..... | 36.55 | 52.54 |
| Fixed carbon in dry purified coal..... | 49.16 | 40.93 |
| In coke..... | 76.31 | 84.82 |

It will be noted that in all cases a very notable reduction in ash is obtained, and that the oil required of specific gravity 0.86, varies from 40 per cent to 47 per cent in the case of the coal received from the Canadian bituminous collieries; and 44 per cent in the case of the Shand lignite. The original ash removed in the Shand lignite is fairly high, namely, 64 per cent. The results of tests conducted at the Trent Process

Corporation laboratories on Shand lignite and North Dakota lignite are also given, together with the time required for treatment. It will be seen that the analyses of the two lignites are very similar, and that a much better ash separation was obtained with the North Dakota lignite, but the difference in time required for agglomeration, namely, 25 minutes for the Shand lignite, is extremely marked. The engineers of the Trent Process Corporation stated, in a letter to me, that they did not get the action so rapidly on the North Dakota lignite owing to a flocculent material that is lighter than water, and remains in suspension. When this material was removed before treatment the time for agglomeration was reduced from 9 hours to 45 minutes, and the material removed analysed 70 per cent non-carbonaceous matter. It is also the belief of the chief engineer to the Corporation, that the difficulty in agglomerating the North Dakota lignite is largely due to its high oxygen content; but no oxygen determination was made on the two samples of coal cited.