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WASHING AND COKING TESTS OF COAL

AT THE FUEL-TESTING PLANT, DENVER, COLO.
JULY 1, 1907, TO JUNE 30, 1908

BY

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By A. W. Belden, G. R. Delamater, and J. W. Groves.

INTRODUCTION.

By A. W. Belden.

The investigations described in this report were undertaken by the Government for the general purpose of increasing efficiency in the utilization of the fuel supply of the United States by devising improvements in washing and coking coals, these being two of the methods of conserving one of the country's most important natural resources.

Specifically, the washing tests of coal were made to determine the possibility of so improving the quality of the coal as to render it available for the production of coke—for the coal used in coking must be as free as possible from ash, sulphur, and other impurities, because of its prospective use in metallurgical processes. The coking tests were made to determine the possibility of utilizing the various coals in this way, or to devise improvements in coking practice. The washing tests have already demonstrated the fact that many coals which are too high in ash and sulphur for economical use under the steam boiler or for coking may be rendered of commercial value by proper treatment in the washery. The coking tests have demonstrated that many coals which were not supposed to be of economical value for coking purposes may be rendered so by proper treatment in the washery and coke oven. Of more than 100 coals from the Mississippi Valley and the Eastern States, some of them regarded as noncoking, which had been tested at St. Louis in 1906, all except six had been found, when carefully manipulated, to make fairly good coke for foundry and other metallurgical purposes, and similar results with western coals have now been obtained at Denver. Of 37 coals tested from the Rocky Mountain region, all but three produced good coke under proper treatment, though a number had been considered noncoking.

The tests detailed in this bulletin are a continuation of the work started several years ago in St. Louis at the Government fuel-testing plant there. On the completion of the work at St. Louis the writer made a trip through the Rocky Mountain region for the purpose of selecting a site for washing and coking tests on coals of the western half of the United States, with the hope of getting into closer touch with the fields from which little or no coal had been received at the testing plant in St. Louis.

The different points available were visited, and after investigation Denver, Colo., was selected as the most suitable on account of its central location and railroad facilities. Through the courtesy of the

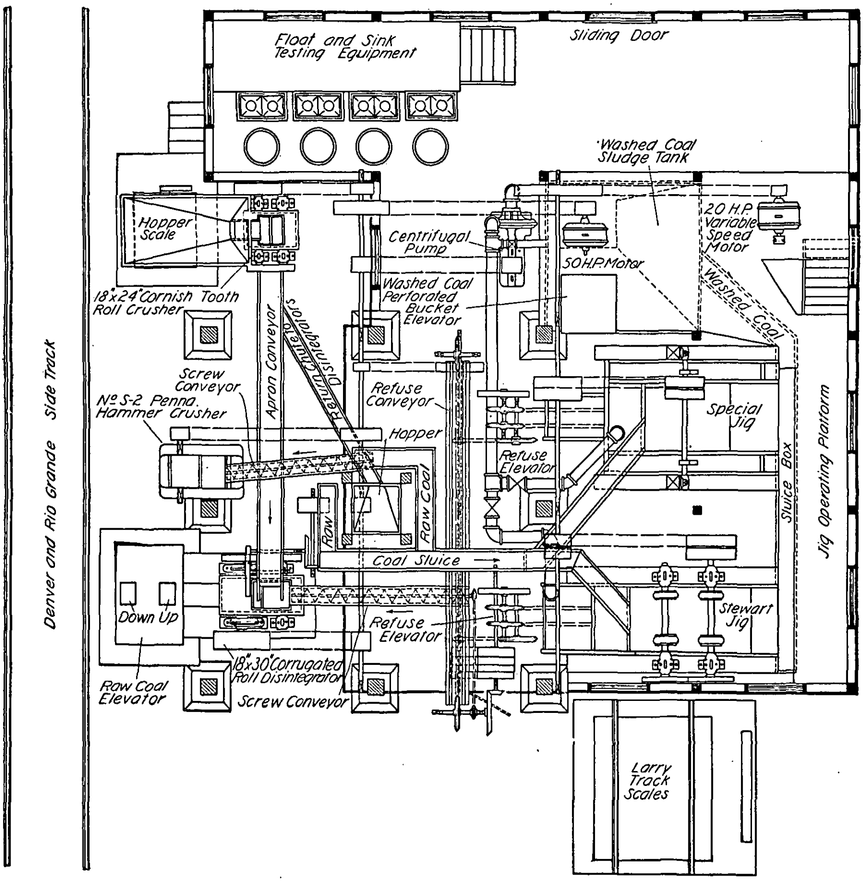
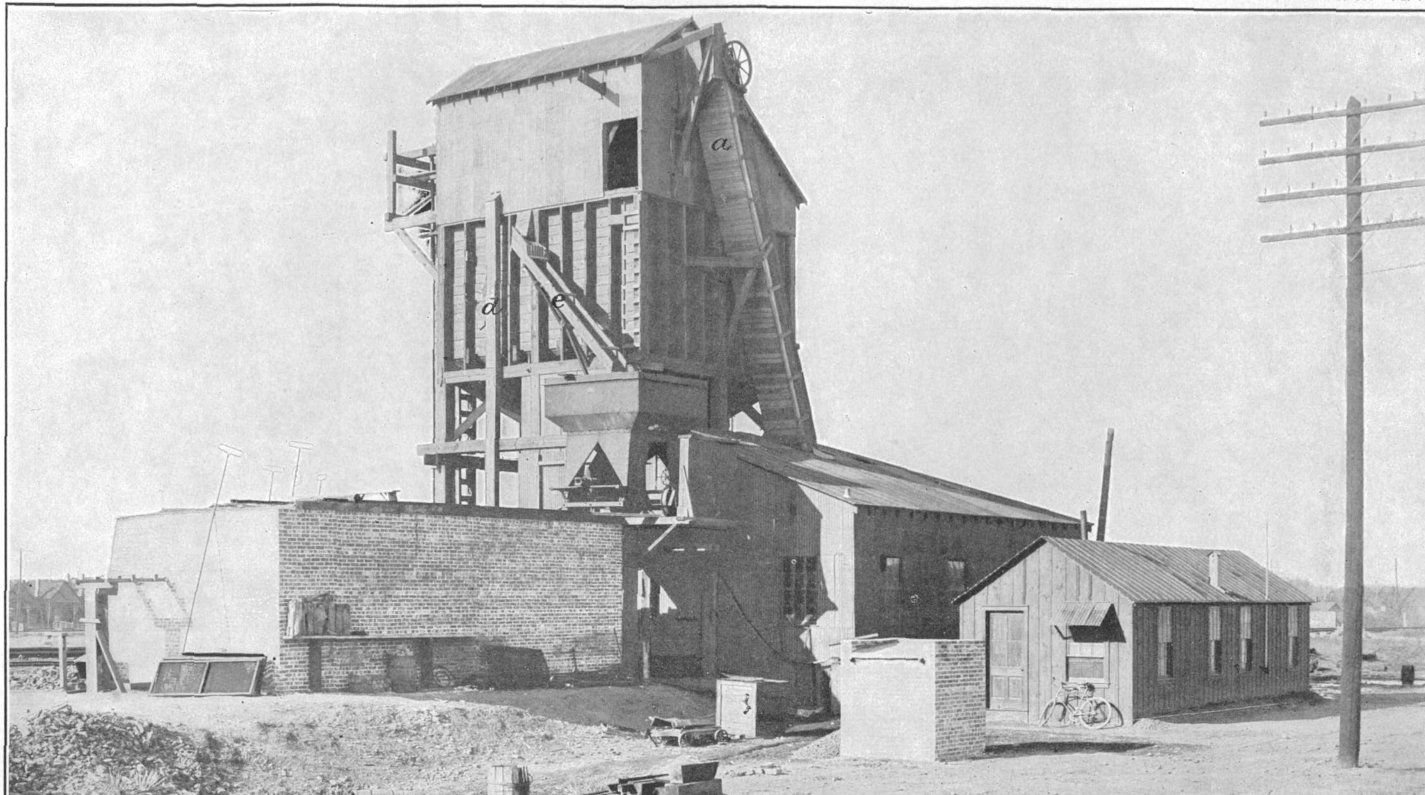


FIG. 1.—Plan of fuel-testing plant, Denver, Colo.

Denver and Rio Grande Railroad Company a site was selected on that railroad's right of way in South Denver. Plans and specifications for the construction of the storage and washery building and the battery of two beehive ovens were prepared and bids asked. The contracts for constructing the buildings and ovens and for supplying the conveying machinery, crushers, motors, etc., were made July 1, 1907. The storage and washery building was completed and accepted on July 31, and the ovens on August 30. Delay due to the



REAR VIEW OF WASHERY BUILDING, COKE OVEN, AND CHEMICAL LABORATORY, FUEL-TESTING PLANT, DENVER, COLO.

nondelivery of the conveying machinery and crushers prevented the completion of the plant until November 19, at which time the first car of coal was unloaded into the storage bins. Views of the plant are shown in Pls. I and II, a plan in fig. 1, and an elevation in fig. 2.

The ovens were fired on November 18, and the actual testing began on November 30. Testing in the washery section began on November 29. From this date to March 21, 1908, when the work was tempo-

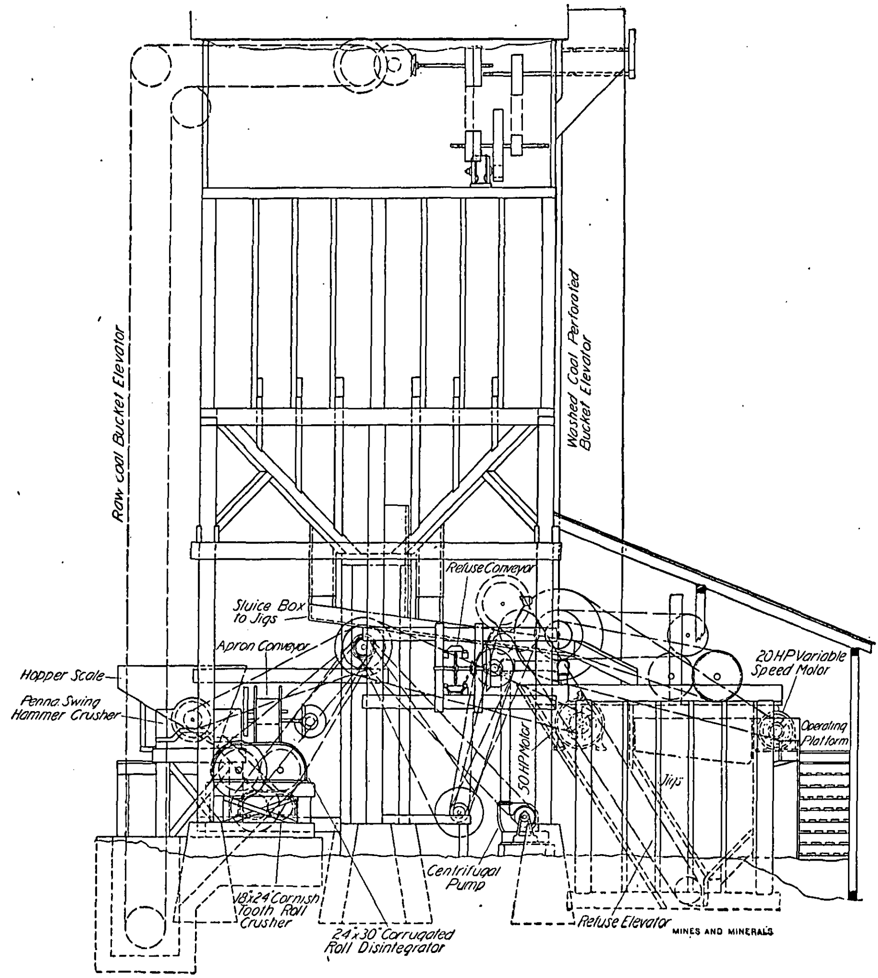


FIG. 2.—Side elevation of fuel-testing plant, Denver, Colo.

rarily suspended, 14 cars of coal were received from three States and one Territory, as follows: Colorado, 11; Montana, 1; New Mexico, 1; and Utah, 1. On these 14 samples the washery section made 34 tests and the coking section 52 tests, and the chemical laboratory 471 analyses, entailing 1,748 different determinations. Detailed reports of the field work, the washery and coking sections, and the chemical work follow in the order named.

FIELD WORK.

By John W. Groves.

INTRODUCTION.

The conditions for submitting coal to be tested and the methods of inspecting the coal and taking the mine samples were the same for the period covered by this report as during the years 1905–6, when the plant was at St. Louis, Mo.

These conditions were as follows:

1. The coal must be furnished to the testing plant free of cost to the Government.
2. The coal must be loaded under the supervision of one of the inspectors employed for that purpose, who shall at the same time be allowed to visit the working places in the mine to secure samples for analysis.
3. When it is possible to do so, the coal should be loaded in box cars and shipped under seal. Lignites must always be shipped in this way.
4. Where the market requires screened coal, this grade will be accepted for tests. The selection of coal is always to be under the direct control of the representative of the testing plant.
5. Where one of the problems involved is the better utilization of slack coal, a carload of slack may be accepted for testing purposes.
6. As soon as possible after the tests are completed, a brief statement of the results will be furnished to parties supplying the coal, for their information, but this must not be made public until the results are published by the Geological Survey.
7. Everyone interested in any particular test or in the general operation of the plant is invited to be present at any time, but the official record of the tests will not be given out except as indicated in the preceding paragraph.
8. In view of the probability of receiving applications from two or more operators working the same bed of coal in the same locality, the right is reserved to accept but one such application, in order that unprofitable duplication of results may be avoided.

INSPECTION PROCEDURE.

In collecting the samples to be shipped to the plant, an inspector visits the mine and carefully examines the coal throughout its extent, making certain that the coal loaded for testing purposes fairly represents the average product of the mine; and that when screened coal is to be sent, the size selected is available to the consumer and adapted to the purpose for which it is to be tested. Therefore, his first duty is to examine the screens and observe the method generally employed in separating the slate and other impurities from the coal while it is being loaded in the railroad car. He then enters the mine and carefully notes the character of the bed, the method of mining, and the amount of care taken by the miners to separate the shale partings and sulphur balls from the coal while loading it into mine cars. While the sample is being loaded into the railroad car the inspector stands inside and permits the slate pickers to discard only such material as is thrown off in the usual practice and as is consistent with the customary speed of loading. The material thrown out is afterwards examined by the inspector to determine why it is considered detrimental to the fuel value of the coal.

MINE SAMPLES.

Two or more samples for chemical analysis are taken by the inspector from working places in the mine. These analyses give the experts at the plant a definite idea of the quality of the coal before the practical tests are begun. They are also useful in showing the composition of the coal in its native condition; especially is this true of the moisture content.

The object of the inspector is to secure a sample that will, as nearly as possible, represent run-of-mine coal. He first makes a careful study of the coal throughout the mine and observes what parts of the bed are discarded by the miner. Two or more places where the coal is of average development are then selected. These places are usually at widely separated points in the part of the mine from which most of the coal is being shipped. The face is then cleared of burned powder, loose coal, and dirt for 5 feet or so, and insecure pieces of the roof are taken down to prevent their falling into the sample. The sampler then spreads a rubber blanket on the floor of the mine close up to the face of the coal and makes a perpendicular cut from floor to roof, including everything in the sample but the parts of the bed discarded by the miner. He cuts sufficient coal to make not less than 5 pounds per foot in height—that is, a sample weighing not less than 30 pounds would be cut from a 6-foot seam of coal. When shale or other partings are to be included in the sample great care is exercised in cutting them the full width and depth of the groove in order to preserve the proper proportion of coal and extraneous matter. When the required amount of coal is obtained a detailed record is made of the section of the bed from top to bottom, every perceptible parting and variation in the section being noted. The parts of the bed not included in the sample are clearly shown in this record, and from these notes the value of the sample may be judged.

The cuttings are at once weighed and then sifted through a screen with a half-inch mesh. The remaining lumps are broken up on a portable bucking board, and this process of screening and breaking is continued until the entire sample will pass through the screen.

The sample is then mixed by two men who stand opposite each other. Grasping the corners of the rectangular blanket, they roll the sample diagonally by raising one corner of the blanket at a time. This mixes the sample very thoroughly, and when the larger pieces are observed to be evenly distributed throughout the mass the sample is divided into four equal parts. Two opposite quarters are discarded and the remainder mixed as before. If the sample is still too bulky to be conveniently handled it is again mixed and quartered.

The remaining material is spread into a circular mass about 2 inches deep on the blanket, and a small trowel is used to fill a sample can with alternate sections of the sample taken from the circumference to the center of the mass around the entire circle. The can is closed and hermetically sealed with electrical insulating tape, and the weight is noted. This weight shows accurately what proportion of the original sample is sent to the laboratory.

The entire process of sampling is carried on as rapidly as possible at the place in the mine where the sample is cut. The maximum time for cutting and preparing a large sample is about one hour. Although it is known that rapid changes take place in the moisture content of some coals, it is reasonable to assume that where the sampling is quickly done in the atmosphere to which the native coal is exposed there is probably only a slight gain or loss of moisture while the sample is being broken up and quartered.

DESIGNATION OF SAMPLES.

The samples of coal sent to the Denver testing plant were designated Denver No. 1, Denver No. 2, and so on, consecutively, Denver being placed before each number to distinguish the samples from those sent to St. Louis, Mo., and Norfolk, Va. The samples are known by these numbers throughout the tests and publications.

In like manner the laboratory numbers of the analyses are followed by the letter D to show that the analyses were made at Denver.

LIST OF SAMPLES TESTED AT DENVER.

The following is a complete list of the samples tested at Denver previous to March 1, 1908:

List of coals tested at Denver, Colo.

[All samples inspected by J. W. Groves.]

Designation of sample.	Kind of fuel.	Name of bed.	Locality.	Railroad.	Days exposed to weather.
Denver No.—					
1	Bituminous, run of mine.		Engleville, Las Animas County, Colo.	Denver and Rio Grande.	14
2	do	No. 2	Tercio, Las Animas County, Colo.	Colorado and Wyoming.	14
3	do	No. 3	do	do	16
4	do		Delagua, Las Animas County, Colo.	Colorado and Southern.	26
5	do	No. 2	Storrs, Gallatin County, Mont.	Northern Pacific	19
6	Bituminous, 1-inch to 3-inch nut.	Lower bed	Shumway, Huerfano County, Colo.	Denver and Rio Grande.	13
7	Bituminous, run of mine.	do	Sopris, Las Animas County, Colo.	Trinidad Electric	10
8	do	do	do	Colorado and Wyoming.	10
9	do		Dawson, Colfax County, N. Mex.	El Paso and South-Western.	21
10	Bituminous, slack through a $\frac{3}{4}$-inch screen.		Hastings, Las Animas County, Colo.	Colorado and Southern.	10
11	Bituminous, run of mine.	Savage	Wootton, Las Animas County, Colo.	Santa Fe	13
12	do	Lower bed	Kenilworth, Carbon County, Utah.	Rio Grande Western.	11
13	Subbituminous, run of mine.		Dacono, Weld County, Colo.	Union Pacific	9
14	Bituminous, run of mine.	Juanita, 14-foot.	Bowie, Delta County, Colo	Denver and Rio Grande.	8

DETAILED DESCRIPTIONS OF SAMPLES.

DENVER NO. 1.

Bituminous coal from Engleville, Las Animas County, Colo., on the Denver and Rio Grande Railroad, was designated Denver No. 1. One sample shipped from this place consisted of 24 tons of run-of-mine coal, and was used in making washing tests 200 and 210 and coking tests 195 and 206. Two mine samples were taken for chemical analysis. Sample 103–D was taken 5,280 feet south of the opening, where the coal measured 7 feet 2½ inches thick as shown in section A; sample 104–D was taken 10,000 feet east of the opening, where the coal measured 7 feet 2 inches thick, as in section B.

Section A (sample 103–D).

	Ft.	in.
Sandstone roof.		
Bone		2
Coal	2	
Bone		2½
Coal	2	6
Bone		2
Coal	2	2
Shale floor.		
	7	2½

Section B (sample 104–D).

	Ft.	in.
Bone coal roof.		
Coal		8
Shale [a]		2
Coal	1	10
Bone		3½
Coal		8
Bone [a]		3
Coal		11
Bone [a]		2½
Coal	1	7
Bone [a]		1
Coal		6
Shale floor.		
	7	2

Chemical analyses of Denver No. 1 coal.

	Mine samples.						Car sample (115–D).		
	103–D.			104–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.90			1.50			1.20		
Prox. Moisture	1.26	3.14		1.31	2.79		1.06	2.25	
Prox. Volatile matter	30.74	30.16	31.14	29.89	29.44	30.29	29.85	29.49	30.17
Prox. Fixed carbon	52.80	51.79	53.46	49.49	48.75	50.15	48.41	47.82	48.92
Prox. Ash	15.20	14.91	15.40	19.31	19.02	19.56	20.68	20.44	20.91
Ult. Sulphur	.69	.68	.70	.59	.58	.60	.65	.64	.65
Ult. Hydrogen								4.59	4.44
Ult. Carbon								65.00	66.50
Ult. Nitrogen								1.13	1.16
Ult. Oxygen								8.20	6.34
Calorific value:									
Determined—									
Calories				6,722	6,621	6,811	6,587	6,508	6,658
British thermal units					11,918	12,260		11,714	11,984
Calculated from ultimate analysis—									
Calories								6,493	6,642
British thermal units								11,687	11,956

[a] Not included in sample.

DENVER NO. 2.

Bituminous coal from No. 2 bed at Tercio, Las Animas County, Colo., on the Colorado and Wyoming Railway, was designated Denver No. 2. One sample shipped from this bed consisted of run-of-mine coal and was used in making washing tests 201, 204, and 209; and coking tests 196, 197, 205, and 206. Two mine samples were taken for chemical analysis. Sample 102–D was taken 900 feet north of the slope, where the coal has the measurements shown in section A below; sample 112–D was taken 1,800 feet north of the slope, where the coal has the measurements shown in section B.

Section A (sample 102–D).

	Ft.	in.
Shale roof.		
Coal	6	9
Shale and sandstone floor.		

Section B (sample 112–D).

	Ft.	in.
Shale roof.		
Coal	1	
Bone		2½
Coal	2	
Bone [a]		3
Coal	2	8
Shale		1
Coal		10
Shale floor.		
	7	½

Chemical analyses of Denver No. 2 coal.

	Mine samples.						Car sample (116–D).		
	102–D.			112–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.10	......	......	2.00	......	......	1.70	......	......
Prox. Moisture	.88	1.97	......	.98	2.96	......	1.19	2.87	......
Prox. Volatile matter	32.59	32.23	32.88	31.10	30.48	31.41	30.46	29.94	30.83
Prox. Fixed carbon	50.63	50.07	51.08	49.35	48.36	49.84	48.89	48.06	49.48
Prox. Ash	15.90	15.73	16.04	18.57	18.20	18.75	19.46	19.13	19.69
Ult. Sulphur	.74	.73	.74	.70	.69	.71	.78	.77	.79
Ult. Hydrogen	......	......	......	......	......	......	......	4.61	4.42
Ult. Carbon	......	......	......	......	......	......	......	65.28	67.21
Ult. Nitrogen	......	......	......	......	......	......	......	1.06	1.09
Ult. Oxygen	......	......	......	......	......	......	......	9.15	6.80
Calorific value:									
Determined—									
Calories	7,061	6,927	7,066	......	......	......	6,624	6,511	6,703
British thermal units	......	12,469	12,719	......	......	......	......	11,720	12,066
Calculated from ultimate analysis—									
Calories	......	......	......	......	......	......	......	6,488	6,680
British thermal units	......	......	......	......	......	......	......	11,768	12,116

DENVER NO. 3.

Bituminous coal from No. 3 bed at Tercio, Las Animas County, Colo., on the Colorado and Wyoming Railway, was designated Denver No. 3. One sample shipped from this bed consisted of 28 tons of run-of-mine coal, and was used in making washing tests 202 and 205,

[a] Not included in sample.

and coking tests 198, 199, and 206. Two mine samples were taken for chemical analysis. Sample 101–D was taken 800 feet north of the slope opening, where the coal measured as shown in section A; sample 111–D was taken 1,000 feet north of the slope opening, where the coal measured as in section B.

Section A (sample 101–D).

	Ft.	in.
Sandy shale roof.		
Coal	3	8
Shale floor.		

Section B (sample 111–D).

	Ft.	in.
Shale roof.		
Coal	1	2
Bone		2
Coal	2	1
Shale floor.		
	3	5

Chemical analyses of Denver No. 3 coal.

	Mine samples.						Car sample (117–D).		
	101–D.			111–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.30			1.60			1.50		
Prox. Moisture	.99	2.28		.98	2.56		1.18	2.66	
Prox. Volatile matter	34.42	33.97	34.76	33.71	33.17	34.04	31.68	31.20	32.06
Prox. Fixed carbon	53.49	52.79	54.02	54.50	53.63	55.04	50.87	50.11	51.47
Prox. Ash	11.10	10.96	11.22	10.81	10.64	10.92	16.27	16.03	16.47
Ult. Sulphur	.69	.68	.70	.68	.67	.69	.69	.68	.69
Ult. Hydrogen								4.86	4.69
Ult. Carbon								68.37	70.24
Ult. Nitrogen								.99	1.02
Ult. Oxygen								9.07	6.89
Calorific value: Determined—Calories	7,563	7,465	7,639				6,875	6,975	7,058
Calorific value: Determined—British thermal units		13,437	13,750					12,366	12,704
Calculated from ultimate analysis—Calories								6,825	7,012
Calculated from ultimate analysis—British thermal units								12,285	12,621

DENVER NO. 4.

Bituminous coal from Delagua, Las Animas County, Colo., on the Colorado and Southern Railway, was designated Denver No. 4. One sample of coal shipped from this place consisted of 41 tons of run-of-mine coal, which was used in making washing tests 203, 206, and 208, and coking tests 200, 201, 202, 203, and 204. Two mine samples were taken for chemical analysis. Sample 113–D was taken 5,200 feet north of the drift opening, where the coal measured as shown in section A; and sample 114–D was taken 7,000 feet north of the opening, where the coal measured as shown in section B.

Section A (sample 113–D).

Shale roof.	Ft.	in.
Bone[a]		6
Coal	1	10
Gray coal		¾
Coal	1	5
Bone		1
Coal	2	½
Bone coal floor.		
	5	11¼

Section B (sample 114–D).

Shale roof.	Ft.	in.
Bone[a]		3
Coal	2	
Coal and pyrites		1½
Coal		10
Coal and pyrites[a]		2
Coal	2	6
Bone coal floor.		
	5	10½

Chemical analyses of Denver No. 4 coal.

	Mine samples.						Car sample (152–D).		
	113–D.			114–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	2.00			1.60			1.00		
Prox. Moisture	1.19	3.17		1.33	2.91		2.21	3.19	
Prox. Volatile matter	36.93	36.19	37.38	36.93	36.34	37.42	34.33	33.99	35.12
Prox. Fixed carbon	52.61	51.56	53.25	53.84	52.98	54.58	51.77	51.25	52.93
Prox. Ash	9.27	9.08	9.37	7.90	7.77	8.00	11.69	11.57	11.95
Ult. Sulphur	.52	.51	.53	.48	.47	.48	.59	.58	.60
Ult. Hydrogen								5.23	5.04
Ult. Carbon								71.44	73.79
Ult. Nitrogen								.99	1.02
Ult. Oxygen								10.19	7.60
Calorific value:									
Determined—									
Calories				7,473	7,353	7,573	7,195	7,123	7,358
British thermal units					13,235	13,631		12,821	13,243
Calculated from ultimate analysis—									
Calories								7,150	7,386
British thermal units								12,870	13,294

DENVER NO. 5.

Bituminous coal from No. 2 bed at Storrs, Gallatin County, Mont., on the Northern Pacific Railway, was designated Denver No. 5. This bed of coal dips at an angle of 45°, and is worked by a tunnel driven to intersect the bed. One sample of coal shipped from this place consisted of 40 tons of run-of-mine coal, and was used in making washing tests 207, 211, and 212, and coking tests 207, 208, 212, and 213. Two mine samples were taken for chemical analysis. Sample 166–D was taken 4,600 feet north of the opening, where the coal measured as shown in section A; sample 167–D was taken 4,000 feet north of the opening, where the coal measurements are as shown in section B.

[a] Not included in sample.

Section A (sample 166–D).

	Ft.	in.
Rash and shale roof.		
Coal		7
Rash [a]		7
Coal	2	
Rash [a]		2
Coal	1	
Rash [a]		1
Coal	1	
Shale [a]		1
Coal		5
Shale floor.		
	5	11

Section B (sample 167–D).

	Ft.	in.
Soft shale roof.		
Coal		6
Clay [a]		2
Coal	1	6
Rash [a]	2	
Coal	3	2
Clay [a]		2
Coal		11
Shale floor.		
	8	5

Chemical analyses of Denver No. 5 coal.

	Mine samples.						Car sample (211-D).		
	166-D.			167-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	3.00			2.00			1.30		
Prox. Moisture	1.91	4.85		2.05	4.01		2.87	4.13	
Prox. Volatile matter	30.91	29.98	31.51	35.24	34.54	35.98	30.02	29.63	30.90
Prox. Fixed carbon	37.57	36.45	38.30	46.41	45.48	47.38	35.84	35.38	36.91
Prox. Ash	29.61	28.72	30.19	16.30	15.97	16.64	31.27	30.86	32.19
Ult. Sulphur	.53	.51	.54	.52	.51	.53	.53	.52	.54
Ult. Hydrogen								4.29	3.99
Ult. Carbon								50.85	53.04
Ult. Nitrogen								.70	.72
Ult. Oxygen								12.78	9.51
Calorific value:									
Determined—									
Calories				6,723	6,589	6,864	5,120	5,053	5,271
British thermal units					11,860	12,355		9,095	9,487
Calculated from ultimate analysis—									
Calories								5,047	5,264
British thermal units								9,085	9,476

DENVER NO. 6.

Bituminous coal from the lower bed at Shumway, Huerfano County, Colo., on the Denver and Rio Grande Railroad, was designated Denver No. 6. One sample shipped from this bed, consisting of 33 tons of nut coal (1 inch to 3 inches), was used in making washing tests 213, 214, and 215, and coking tests 209, 210, 211, 214, 220, and 224. Two mine samples were taken for chemical analysis. Sample 222–D was taken 560 feet southwest of the shaft where the coal measured as shown in section B; sample 223–D was taken 500 feet northwest of the shaft where the coal measured as shown in section A.

[a] Not included in sample.

Section A (sample 223-D).

	Ft.	in.
Shale roof.		
Coal	5	7
Shale floor.		

Section B (sample 222-D).

	Ft.	in.
Shale roof.		
Coal	1	3
Shale [a]		2½
Coal	2	3
Shale [a]		1
Coal	1	7
Shale floor.		
	5	4½

Chemical analyses of Denver No. 6 coal.

	Mine samples.						Car sample (240-D).		
	222-D.			223-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.10			0.70			1.80		
Prox. Moisture	4.23	5.28		4.93	5.60		4.33	6.05	
Prox. Volatile matter	36.80	36.40	38.43	37.41	37.15	39.35	36.09	35.45	37.73
Prox. Fixed carbon	46.81	46.29	48.87	46.01	45.68	48.39	40.37	39.64	42.19
Prox. Ash	12.16	12.03	12.70	11.65	11.57	12.26	19.21	18.86	20.08
Ult. Sulphur	1.22	1.21	1.28	.83	.79	.84	1.06	1.04	1.11
Ult. Hydrogen								4.92	4.52
Ult. Carbon								58.30	62.05
Ult. Nitrogen								.98	1.04
Ult. Oxygen								15.90	11.20
Calorific value:									
Determined—									
Calories	6,577	6,505	6,868				5,969	5,862	6,239
British thermal units		11,709	12,362					10,552	11,232
Calculated from ultimate analysis—									
Calories								5,744	6,114
British thermal units								10,339	11,004

DENVER NO. 7.

Bituminous coal from the lower bed at Sopris, Las Animas County, Colo., on the Trinidad Electric Road, was designated Denver No. 7. One sample from this bed, consisting of 32 tons of run-of-mine coal, was used in making washing tests 216, 218, and 222 and coking tests 215, 216, 220, 221, and 224. Two mine samples were taken for chemical analysis. Sample 230-D was taken 1,200 feet southwest from the slope opening, where the coal measured as shown in section A; sample 231-D was taken 3,000 feet west of the slope, where the coal measured as shown in section B.

Section A (sample 230-D).

	Ft.	in.
Roof, 4 inches of bone with shale above it.		
Coal	1	11
Bone [a]		1½
Coal	1	9
Shale floor.		
	3	9½

Section B (sample 231-D).

	Ft.	in.
Shale roof.		
Bone coal		6
Coal		7
Shale [a]		1½
Coal	2	2
Block shale floor.		
	3	4½

[a] Not included in sample.

Chemical analyses of Denver No. 7 coal.

	Mine samples.						Car sample (245-D).		
	230-D.			231-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	2.70			0.70			0.90		
Prox. Moisture	.84	3.52		.93	1.62		1.07	1.96	
Prox. Volatile matter	29.90	29.09	30.15	29.37	29.16	29.66	29.08	28.82	29.40
Prox. Fixed carbon	56.15	54.63	56.62	59.97	59.56	60.54	51.86	51.39	52.42
Prox. Ash	13.11	12.75	13.23	9.73	9.66	9.80	17.99	17.83	18.18
Ult. Sulphur	.72	.70	.73	.73	.72	.73	.68	.67	.68
Ult. Hydrogen								4.61	4.48
Ult. Carbon								69.46	70.85
Ult. Nitrogen								1.08	1.10
Ult. Oxygen								6.35	4.71
Calorific value:									
Determined—									
Calories				7,769	7,715	7,842	6,993	6,930	7,069
British thermal units					13,887	14,116		12,474	12,723
Calculated from ultimate analysis—									
Calories								6,944	7,083
British thermal units								12,499	12,749

DENVER NO. 8.

Bituminous coal from the lower bed at Sopris, Las Animas County, Colo., was designated Denver No. 8. One sample from this bed, consisting of 32 tons of run-of-mine coal, was used in making washing tests 217, 225, 226, and 227 and coking tests 226, 227, 228, 235, 238, and 239. Two samples were taken in the mine for chemical analysis. Sample 232-D was taken 2,600 feet southwest from the slope, where the coal measured as shown in section B; sample 233-D was taken 2,600 feet southeast from the slope, where the coal measured as shown in section A.

Section A (sample 233-D).

	Ft.	in.
Shale roof.		
Coal		4½
Shale [a]		1½
Coal	1	
Shale [a]		1
Coal	1	5
Bone		¾
Coal		8
Shale floor.		
	3	8¾

Section B (sample 232-D).

	Ft.	in.
Shale roof.		
Coal		7½
Shale [a]		1
Coal		9
Shale [a]		1½
Coal	3	2½
"Blackjack" floor.		
	4	9½

[a] Not included in sample.

Chemical analyses of Denver No. 8 coal.

	Mine samples.						Car sample (300-D).		
	232-D.			233-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.60			1.40			0.30		
Prox. Moisture	.63	2.22	0.71	.71	2.10		1.14	1.44	
Prox. Volatile matter	30.57	30.08	30.77	29.56	29.15	29.77	28.46	28.37	28.78
Prox. Fixed carbon	58.72	57.78	59.08	56.53	55.74	56.92	53.52	53.36	54.14
Prox. Ash	10.08	9.92	10.15	13.20	13.01	13.31	16.88	16.83	17.08
Ult. Sulphur	.70	.69	.71	.66	.65	.66	.72	.72	.73
Ult. Hydrogen								4.36	4.26
Ult. Carbon								69.99	71.01
Ult. Nitrogen								1.05	1.07
Ult. Oxygen								7.05	5.85
Calorific value:									
Determined—									
Calories				7,468	7,363	7,521	7,091	7,070	7,173
British thermal units					13,253	13,538		12,726	12,912
Calculated from ultimate analysis—									
Calories								6,871	6,971
British thermal units								12,368	12,549

DENVER NO. 9.

Bituminous coal from Dawson, Colfax County, N. Mex., was designated Denver No. 9. One sample shipped from this place consisted of 32 tons of run-of-mine coal, and was used in making washing tests 220, 223, 224, and 229 and coking tests 222, 223, 225, 237, and 241. One mine sample (256-D) for chemical analysis was taken about 6,000 feet north of the opening, where the coal measured as shown in section A.

Section A (sample 256-D).

	Ft.	in.
Bone coal roof.		
Coal		5
Shale [a]		3
Coal	1	4
Shale		1
Coal	3	
Shale		1
Coal		7
Bone coal floor with shale below.		
	5	9

[a] Not included in sample.

Chemical analyses of Denver No. 9 coal.

	Mine sample (256-D).			Car sample (271-D).		
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	0.70			None.		
Prox. Moisture	1.48	2.17			1.96	
Prox. Volatile matter	38.20	37.93	38.78		35.96	36.68
Prox. Fixed carbon	45.40	45.08	46.08		46.20	47.12
Prox. Ash	14.92	14.82	15.14		15.88	16.20
Ult. Sulphur	.69	.69	.71		.75	.77
Ult. Hydrogen					5.01	4.88
Ult. Carbon					68.26	69.62
Ult. Nitrogen					1.01	1.03
Ult. Oxygen					9.09	7.50
Calorific value:						
Determined—						
Calories	7,041	6,992	7,147		6,913	7,051
British thermal units		12,586	12,865		12,443	12,692
Calculated from ultimate analysis—						
Calories					6,866	7,703
British thermal units					12,359	12,606

DENVER NO. 10.

Bituminous coal from Hastings, Las Animas County, Colo., was designated Denver No. 10. One sample from this place consisted of 29 tons of slack (¾-inch screenings) and was used in making washing tests 219 and 221 and coking tests 217, 218, and 219. Two mine samples were taken for chemical analysis. Sample 254–D was taken 3,800 feet south of the slope, where the coal measured as shown in section A; sample 255–D was taken 4,600 feet south of the slope, where the coal measured as shown in section B.

Section A (sample 254-D).

	Ft.	in.
Shale roof.		
Coal	1	10
Hard coal		2
Coal	3	3
Shale floor.		
	5	3

Section B (sample 255-D).

	Ft.	in.
Shale roof.		
Coal	2	11
Pyrites [a]		¾
Coal	1	9
Bone [a]	1	3
Coal	1	9
Bone		1
Coal	1	4
Shale floor.		
	9	1¾

[a] Not included in sample.

Chemical analyses of Denver No. 10 coal.

	Mine samples.						Car sample (272-D).		
	254-D.			255-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	0.20			1.40			0.60		
Prox. Moisture	1.34	1.54		1.37	2.75		1.78	2.37	
Prox. Volatile matter	34.81	34.74	35.29	35.48	34.98	35.96	31.69	31.50	32.26
Prox. Fixed carbon	54.20	54.09	54.93	52.68	51.92	53.40	47.26	46.98	48.12
Prox. Ash	9.65	9.63	9.78	10.47	10.35	10.64	19.27	19.15	19.62
Ult. Sulphur	.63	.63	.64	.67	.66	.68	.74	.74	.76
Ult. Hydrogen								4.75	4.61
Ult. Carbon								66.17	67.78
Ult. Nitrogen								.97	.99
Ult. Oxygen								8.22	6.24
Calorific value:									
Determined—									
Calories	7,604	7,589	7,708				6,638	6,598	6,758
British thermal units		13,660	13,874					11,876	12,164
Calculated from ultimate analysis—									
Calories								6,645	6,806
British thermal units								11,961	12,251

DENVER NO. 11.

Bituminous coal from the Savage bed at Wootton, Las Animas County, Colo., was designated Denver No. 11. One sample shipped from this bed consisted of 25 tons of run-of-mine coal, and was used in making washing tests 228, 230, and 231 and coking tests 230, 236, and 240. Two mine samples were taken for chemical analysis. Sample 257–D was taken 260 feet west of the opening, where the coal measured as shown in section A; sample 258–D was taken 275 feet west of the opening, where the coal measured as shown in section B.

Section A (sample 257-D).

Bone coal and shale roof.	Ft.	in.
Coal	1	
Shale [a]		1
Coal	1	10
Bone [a]		2
Coal	1	3
Shale [a]		1
Coal		4½
Bone coal floor.	4	9½

Section B (sample 258-D).

Bone coal and shale roof.	Ft.	in.
Coal	1	
Shale and coal [a]		1¼
Coal	2	10
Shale and coal [a]		1
Coal		7
Shale [a]		1¼
Coal		5
Shale floor.	5	1½

[a] Not included in sample.

Chemical analyses of Denver No. 11 coal.

	Mine samples.						Car sample (345-D).		
	257-D.			258-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	0.60			0.30			0.60		
Prox. Moisture	1.74	2.33		1.86	2.15		2.18	2.77	
Prox. Volatile matter	36.30	36.08	36.95	34.65	34.55	35.31	33.32	33.12	34.08
Prox. Fixed carbon	47.25	46.97	48.10	49.68	49.53	50.62	45.57	45.29	46.56
Ash	14.71	14.62	14.95	13.81	13.77	14.07	18.93	18.82	19.36
Ult. Sulphur	.63	.63	.65	.68	.68	.69	.62	.62	.64
Ult. Hydrogen								4.83	4.65
Ult. Carbon								64.45	66.29
Ult. Nitrogen								1.17	1.20
Ult. Oxygen								10.11	7.86
Calorific value:									
Determined—									
Calories	7,001	6,959	7,125				6,529	6,490	6,675
British thermal units		12,526	12,825					11,682	12,015
Calculated from ultimate analysis—									
Calories								6,452	6,636
British thermal units								11,614	11,945

DENVER NO. 12.

Bituminous coal from the lower bed of coal at Kenilworth, Carbon County, Utah, was designated Denver No. 12. One sample shipped from this bed consisted of 40 tons of run-of-mine coal and was used in making coking tests 229, 231, 232, 234, 237, 238, and 239. Two mine samples were taken for chemical analysis. Sample 352-D was taken 650 feet northwest of the slope opening, where the coal measured as shown in section A; sample 353-D was taken 1,100 feet northwest of the slope opening, where the coal measured as shown in section B.

Section A (sample 352-D).

	Ft.	in.
Shale roof.		
Coal	1	7
Bone coal		½
Coal		11
Bone coal		½
Coal	2	7
Shale and bone		1
Coal	2	7
Bone coal [a]		1¼
Coal	4	
Shale [a]		¾
Coal	1	
Sandstone floor.		
	13	

Section B (sample 353-D).

	Ft.	in.
Sandstone roof.		
Coal	1	10
Bone coal and pyrites [a]		1½
Coal	1	2
Bone coal		½
Coal	2	2
Bone coal [a]		1
Coal [a]		2½
Bone coal [a]		2
Coal	7	4
Sandstone floor.		
	13	1½

[a] Not included in sample.

Chemical analyses of Denver No. 12 coal.

	Mine samples.						Car sample (346-D).		
	352-D.			353-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	2.00	....	....	1.40	....	....	1.10	....	....
Prox. Moisture	3.98	5.90	....	3.81	5.16	....	4.53	5.58	....
Prox. Volatile matter	40.93	40.11	42.63	41.29	40.71	42.92	39.35	38.92	41.22
Prox. Fixed carbon	48.68	47.70	50.69	49.47	48.78	51.44	47.03	46.51	49.26
Prox. Ash	6.41	6.29	6.68	5.43	5.35	5.64	9.09	8.99	9.52
Ult. Sulphur	.37	.36	.38	.33	.33	.36	.52	.51	.54
Ult. Hydrogen	....	....	....	....	....	....	....	5.27	4.92
Ult. Carbon	....	....	....	....	....	....	....	67.84	71.85
Ult. Nitrogen	....	....	....	....	....	....	....	1.07	1.14
Ult. Oxygen	....	....	....	....	....	....	....	16.31	12.03
Calorific value:									
Determined—									
Calories	....	....	....	7,252	7,150	7,539	6,836	6,761	7,161
British thermal units	....	....	....	....	12,870	13,570	....	12,170	12,889
Calculated from ultimate analysis—									
Calories	....	....	....	....	....	....	....	6,606	6,996
British thermal units	....	....	....	....	....	....	....	11,891	12,594

DENVER NO. 13.

Subbituminous coal from Dacono, Weld County, Colo., on the Union Pacific Railroad, was designated Denver No. 13. One sample shipped from this bed consisted of 33 tons of run-of-mine coal, and was used in making coking tests 233, 234, and 235. Two mine samples were taken for chemical analysis. Sample 350-D was taken 1,100 feet west of the shaft, where the coal measured as shown in section A; sample 351-D was taken 1,100 feet north of the shaft, where the coal measured as shown in section B.

Section A (sample 350-D)

	Ft.	in.
Roof, 3 feet of coal with shale above[a]		
Coal	5	1
Shale floor.		

Section B (sample 351-D).

	Ft.
Roof, 3 feet of coal with shale above[a]	
Coal	6
Shale floor.	

[a] Not included in sample.

Chemical analyses of Denver No. 13 coal.

	Mine samples.						Car sample (363-D).		
	350-D.			351-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air drying loss	7.10			10.50			2.20		
Prox. Moisture	17.65	23.50		15.67	24.52		20.45	22.20	
Prox. Volatile matter	39.01	36.24	47.37	38.03	34.04	45.10	40.11	39.23	50.42
Prox. Fixed carbon	38.82	36.06	47.14	41.97	37.56	49.76	33.87	33.12	42.57
Prox. Ash	4.52	4.20	5.49	4.33	3.88	5.14	5.57	5.45	7.01
Ult. Sulphur	.37	.34	.44	.34	.30	.40	.34	33	.42
Ult. Hydrogen								6.17	4.76
Ult. Carbon								55.01	70.71
Ult. Nitrogen								.98	1.26
Ult. Oxygen								32.06	15.84
Calorific value:									
Determined—									
Calories				5,864	5,248	7,046	5,441	5,321	6,839
British thermal units					9,446	12,683		9,578	12,311
Calculated from ultimate analysis—									
Calories								5,197	6,680
British thermal units								9,355	12,024

DENVER NO. 14.

Bituminous coal from the Juanita 14-foot bed at Bowie, Delta County, Colo., on the Denver and Rio Grande Railroad, was designated Denver No. 14. One sample shipped from this bed consisted of 34 tons of run-of-mine coal, and was used in making coking tests 242, 243, 244, 245, and 246. Two mine samples were taken for chemical analysis. Sample 378-D was taken 900 feet northwest of the opening, where the coal measured as shown in section A; sample 379-D was taken 1,070 feet northwest of the opening, where the coal measured as shown in section B.

Section A (sample 378-D).

	Ft.	in.
Roof, 6 feet of good coal.[a]		
Coal	6	10
Shale floor.		

Section B (sample 379-D).

	Ft.	in.
Coal roof.[a]		
Coal	7	5
Shale floor.		

[a] Not included in sample.

Chemical analyses of Denver No. 14 coal.

	Mine samples.						Car sample (399-D).		
	378-D.			379-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	0.50			0.90			0.90		
Prox. Moisture	2.03	2.52		3.51	4.38		2.41	3.29	
Prox. Volatile matter	39.53	39.33	40.35	40.66	40.29	42.14	40.10	39.74	41.09
Prox. Fixed carbon	53.42	53.16	54.53	51.39	50.93	53.26	52.64	52.16	53.94
Ash	5.02	4.99	5.12	4.44	4.40	4.60	4.85	4.81	4.97
Sulphur	.59	.59	.61	.62	.61	.64	.63	.62	.64
Ult. Hydrogen								5.69	5.51
Ult. Carbon								74.33	76.86
Ult. Nitrogen								.99	1.02
Ult. Oxygen								13.56	11.00
Calorific value:									
Determined—									
Calories	7,616	7,578	7,774				7,500	7,433	7,686
British thermal units		13,640	13,993					13,379	13,834
Calculated from ultimate analysis—									
Calories								7,398	7,650
British thermal units								13,316	13,769

WASHING TESTS.

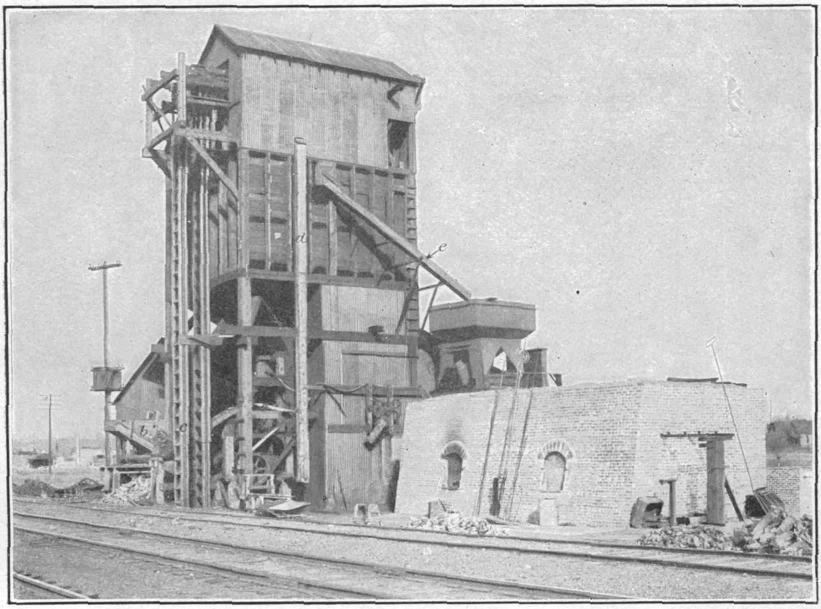
By G. R. Delamater.

PLANT ARRANGEMENT AND OPERATING SYSTEM.

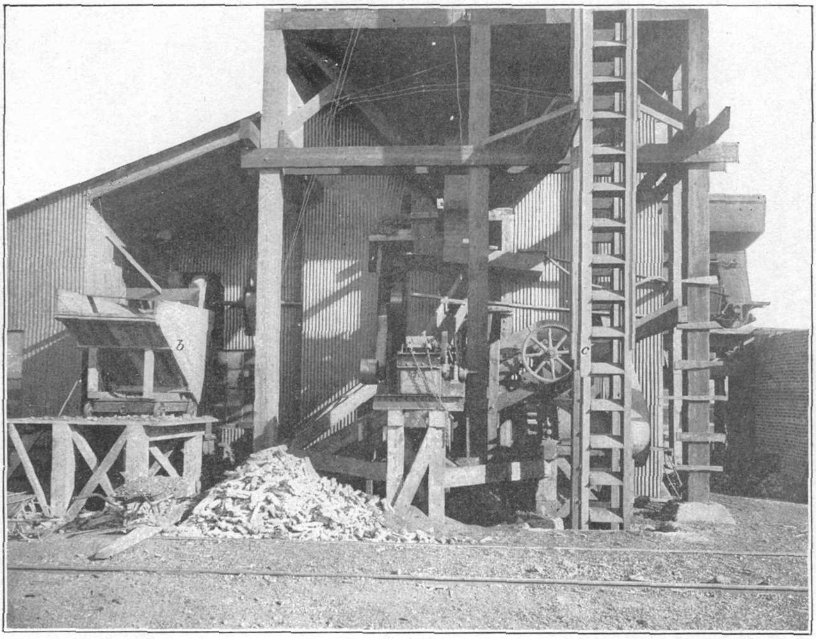
The raw coal as received at the plant is shoveled from the railroad cars to the hopper scale (*b*, Pl. II) and weighed. It then passes through the toothed-roll crusher, where the lumps are broken down to a maximum size of 2½ inches, and from there is conveyed on the apron conveyor to the raw-coal elevator (*c*, Pl. II), the roll disintegrator being passed by, and delivered by this elevator to one of six storage bins. As the coal is thus elevated, an average sample is taken for the laboratory. An analysis is made of this sample and the raw-coal float-and-sink tests are run to determine the size to which it is necessary to crush before washing, and the percentage of refuse giving the best efficiency. From the data thus obtained, the washing machines are adjusted and the washing test is made with full knowledge of the separations possible under varying percentages of refuse. The raw coal is drawn from the bin and delivered to the corrugated-roll disintegrator, where it is crushed down to the size found most efficient and is then delivered by means of the raw-coal elevator to another storage bin.

The arrangement of the plant is such that the coal may be first washed on the Stewart jig, the refuse then being delivered to and rewashed on the special jig (see fig. 3); or it may be first recrushed and then rewashed.

Coal from all the crushers is delivered to the raw-coal elevator. A special feature of the bin system is the arrangement of the draw-off



A. FRONT VIEW OF WASHERY BUILDING AND COKE OVEN, FUEL-TESTING PLANT, DENVER, COLO., FROM LOADING TRACK.



B. DETAILED VIEW OF LOWER PART OF WASHERY.

chutes. They extend vertically about 4 feet downward from the bottom of the bins to the sluice boxes running to the jigs. A gate is provided in this vertical section for regulating the flow of coal. When the coal is to be washed it drops straight down to the sluice box, where it is mixed with the water and sluiced to the jigs. However, in drawing off the washed coal, or when the uncrushed raw coal is to be drawn from a bin and crushed for the washing tests as above stated, a gate just below the coal-flow regulating gate mentioned is thrown in, and the coal falls into a central hopper (see fig. 1) instead of the sluice box. Ordinarily this gate forms one side of the vertical chute. The coal in this central hopper is carried by a chute to the

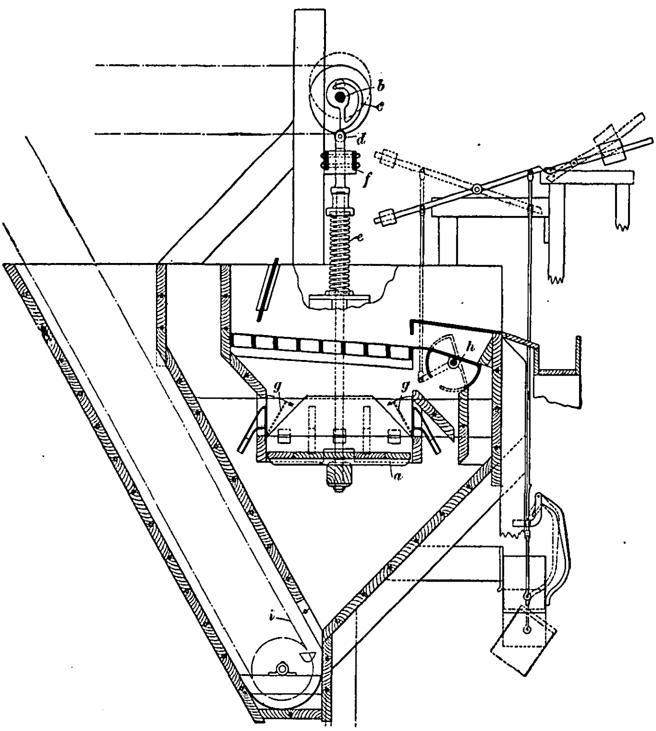


FIG. 3.—Special jig for coal washing.

apron conveyor and thence to the roll disintegrator, or, in case it is washed coal, to the swing-hammer crusher. It will be noted that coal can in this manner be drawn from a bin at the same time that coal is being taken from another bin and sluiced to the jigs for washing, the two operations not interfering in the least.

The washed coal, after being crushed and elevated to the top of the building, is conveyed by a chute (*e*, Pls. I and II, *A*) to the coke-oven larry, and is weighed on the track scale, after which it is charged to the oven. The refuse is sampled and weighed as it is wheeled to the dump pile, and from this sample the analysis is made and a float-and-sink test run to determine the "loss of good coal" (see p. 27) in the refuse. This test shows the efficiency of the washing test.

TEST REVIEW.

It will be noted that all analyses have been reduced to a dry basis. This was done in order that a better comparison might be made of the raw and the washed coal, for it will be readily understood that in many cases the moisture in the washed coal will be so much higher than that in the raw coal that the percentage of ash in an analysis "as received" will be lower than in an analysis reduced to a dry basis. In other words, when the percentages of ash in the raw and in the washed coal are compared by using the analysis "as received," the comparison is not made with the two samples on the same basis. It is of course true that an operator is interested in the moisture carried by the washed coal. This item, however, will vary greatly, depending on the way the washed coal is stored and handled after coming from the washing machines. By this is meant that in many plants the coal drawn from the bottom of the storage bin is the wettest coal in the bin, even though it was delivered thereto hours before the coal in the top of the bin. In the Survey plant this washed coal often stood in the bin a sufficient time to become thoroughly drained, and it would be hardly fair to say that an analysis of such coal "as received" would represent the moisture that would be found where the coal could not be permitted to drain in this manner. However, the analyses of the coal "as received" will be found on pages 11–24.

It should be remembered that in reviewing these tests it was necessary to consider principally the quality of the resulting washed coal and not so much the percentage of refuse or waste matter; for some districts which have only very poor coal must use that or none, the cost of good coal brought from other districts being excessive. Therefore, where to those in good coal districts it may seem useless to talk of wasting 40 or 50 per cent of the coal, to those in poor coal districts such waste may present the only possibility of obtaining any coal at a price not prohibitory.

DETAILS OF TESTS.

In the following table, in the column headed "Loss of good coal in refuse," good coal means all free coal in the refuse, the analysis of which is the same or nearly the same as that of the washed coal. The percentage of loss given is obtained by adding the amount of washed coal to the amount of "good coal" in the refuse, and calculating the percentage in this total of the "good coal" found in the refuse.

General data of washing tests at Denver, Colo., 1907–8.

Denver No.	Test.	Date.	Duration.	Size of coal.		Jig used.			Raw coal used.	Washed coal.		Refuse.		Loss of good coal in refuse.
				As shipped.	As washed.	Name.	Speed.[a]	Stroke.		Amount.	Per cent.	Amount.	Per cent.	
	No.		H.m.					In.	Ts.	Ts.		Ts.		P.ct.
1	200	11, 30, 07	3 00	Run-of-mine	1 inch	Special	65	3	9.30	6.60	71	2.70	29	12
1	210	1, 4, 08	50	do	1 inch	do	80	4	6.41	4.41	69	2.00	31	15
2	201	12, 2, 07	3 00	do	1 inch	do	80	4	12.25	10.65	87	1.60	13	6
2	204	12, 4, 07	1 25	do	1 inch	do	80	4	10.23	9.00	88	1.23	12	3
2	209	1, 2, 08	1 5	do	1 inch	do	80	4	4.74	3.41	72	1.33	28	12
3	202	12, 9, 07	1 45	do	1 inch	do	80	4	10.00	8.60	86	1.40	14	8
3	205	12, 12, 07	35	do	¾ inch	do	80	4	6.66	5.85	88	.81	12	4
4	203	12, 16, 07	1 5	do	¾ inch	do	70	4	6.64	6.00	90	.64	10	4
4	206	12, 21, 07	3 5	do	¾ inch	do	80	4	12.98	10.68	82	2.30	18	14
4	208	12, 26, 07	2 00	do	¾ inch	do	110	2½	8.00	5.80	73	2.20	27	17
5	207	1, 6, 08	3 00	do	Run-of-mine	do	108	1½	10.14	6.25	62	3.89	38	14
5	211	1, 8, 08	2 20	do	do	do	110	2½	6.83	4.33	64	2.50	36	18
5	212	1, 11, 08	3 15	do	do	do	80	4½	13.94	7.68	55	6.26	45	26
5	[b]212	1, 23, 08	2 00	do	do	do	110	2½	7.68	6.62	86	1.06	14	9
6	213	1, 14, 08	3 40	Nut	Nut	Stewart	42	6	12.27	9.06	74	3.21	26	22
6	[c]213	2, 12, 08	1 00	do	1 inch	Special	110	2½	3.16	2.35	75	.81	25	14
6	214	1, 17, 08	1 00	do	1 inch	do	80	4½	5.86	4.80	82	1.06	18	11
6	215	1, 24, 08	3 15	do	Nut	do	80	4½	5.25	3.47	66	1.78	34	14
7	216	1, 28, 08	3 30	Run-of-mine	Run-of-mine	do	80	4½	11.44	8.91	78	2.53	22	9
7	218	1, 30, 08	1 30	do	do	do	80	4½	5.52	4.08	74	1.44	26	9
7	222	2, 5, 08	6 30	do	do	do	110	2½	13.90	10.54	76	3.36	24	10
8	217	2, 14, 08	2 35	do	2 inch	do	108	3½	6.30	5.00	80	1.30	20	6
8	225	2, 15, 08	1 45	do	¾ inch	do	108	3½	8.00	6.00	75	2.00	25	7
8	226	2, 18, 08	2 00	do	¾ inch	do	96	3½	6.15	4.45	73	1.70	27	10
8	227	2, 19, 08	1 50	do	¾ inch	do	106	2½	7.95	6.00	76	1.95	24	7
9	220	2, 10, 08	2 00	do	1 inch	do	110	2½	8.00	6.62	83	1.38	17	8
9	223	2, 11, 08	1 50	do	1 inch	do	110	2½	6.63	5.29	80	1.34	20	9
9	224	2, 13, 08	2 35	do	2 inches	do	108	3½	7.88	6.04	77	1.84	23	8
9	229	2, 27, 08	1 55	do	¾ inch	do	110	2½	8.72	7.20	83	1.52	17	6
10	219	1, 31, 08	1 30	Slack	Slack	do	80	4½	6.53	5.16	79	1.37	21	10
10	221	2, 3, 08	6 35	do	do	do	110	2½	17.04	13.67	80	3.37	20	9
11	228	2, 21, 08	2 00	Run-of-mine	¾ inch	do	108	2½	7.89	5.38	68	2.51	32	17
11	230	2, 28, 08	1.05	do	2 inches	do	110	2¼	8.05	6.63	83	1.42	17	6
11	231	3, 4, 08	1 45	do	2 inches	do	112	2½	8.82	6.90	79	1.92	21	8

[a] Revolutions per minute.
[b] Washed coal from test 212 rewashed.
[c] Refuse from test 213 recrushed and rewashed.

In the following table the figures in the columns headed "Per cent reduction" represent the comparison between the proportion of specified impurities in the raw coal and in the washed coal. Those in the columns headed "Per cent removed" represent the percentages of the specified impurities in the raw coal which were removed by washing.

These figures are determined by the following formulæ:

Let X=the percentage of reduction of any constituent.

Y=the percentage of any constituent removed by washing.

M=the percentage that the amount of the constituent in the washed coal is of the raw coal.

a=the percentage that the washed coal is of the raw coal.

b=the percentage of the constituent in the washed coal.

c=the percentage of the constituent in the raw coal.

Then $X=\frac{c-b}{c}$, $M=ab$, and $Y=\frac{c-M}{c}$.

Analyses of coals at Denver, Colo., 1907-8.

[All reduced to a dry basis for better comparison.]

Denver No.	Test No.	Raw coal				Washed coal								Refuse			
								Ash.			Sulphur.						
		Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Volatile matter.	Fixed carbon.	Per cent.	Per cent reduction.	Per cent removed.	Per cent.	Per cent reduction.	Per cent removed.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
1	200	30.17	48.92	20.91	0.65	33.08	53.75	13.17	37	55	0.63	3	31	24.32	39.09	36.59	0.58
	210	30.17	48.92	20.91	.65	31.67	52.98	15.35	27	49	.65	.....	31	23.28	33.42	43.30	.73
2	201	30.83	49.48	19.69	.79	32.02	51.75	16.23	18	28	.78	1	14	23.94	29.62	46.44	1.72
	204	30.83	49.48	19.69	.79	32.03	52.39	15.58	21	30	.79	.....	11	22.62	27.54	49.84	1.61
	209	30.83	49.48	19.69	.79	31.70	54.57	13.73	30	50	.74	6	33	20.52	28.88	50.60	.98
3	202	32.06	51.47	16.47	.69	32.48	54.05	13.47	18	30	.70	.....	13	No sample.			
	205	32.06	51.47	16.47	.69	33.03	54.55	12.42	8	19	.75	.....	6	22.53	33.21	44.26	1.06
4	203	35.12	52.93	11.95	.60	36.90	53.36	9.74	19	27	.50	17	25	26.86	29.05	44.09	.77
	206	35.12	52.93	11.95	.60	36.21	53.96	9.82	18	33	.53	12	28	32.40	44.24	23.36	.51
	208	35.12	52.93	11.95	.60	36.46	53.86	9.67	19	41	.54	10	35	26.81	36.71	36.48	.72
5	207	30.90	36.91	32.19	.54	35.53	44.31	20.16	37	61	.61	.....	30	23.34	26.43	50.23	.58
	211	30.90	36.91	32.19	.54	35.18	44.47	20.35	37	60	.64	.....	24	22.53	23.11	54.36	.65
	212	30.90	36.91	32.19	.54	34.84	44.97	20.19	37	66	.58	.....	41	22.70	21.71	55.59	.61
	[a] 212	30.90	36.91	32.19	.54	36.83	47.82	15.35	52	77	.60	.....	46	27.63	42.18	30.19	.58
6	213	37.73	42.19	20.08	1.11	39.63	47.61	12.76	36	53	.95	14	37	36.68	43.01	20.31	.91
	[b] 213	37.73	42.19	20.08	1.11	39.47	47.82	12.71	37	54	.83	9	32	23.71	42.71	33.58	1.44
	214	37.73	42.19	20.08	1.11	40.82	45.86	13.32	34	46	.92	17	32	32.31	34.36	33.33	1.57
	215	37.73	42.19	20.08	1.11	41.93	46.68	11.39	43	63	.94	15	44	34.14	39.30	26.56	1.33
7	216	29.40	52.42	18.18	.68	30.99	56.70	12.31	32	47	.70	.....	19	23.07	39.09	37.84	.66
	218	29.40	52.42	18.18	.68	29.72	56.67	13.61	25	45	.63	7	31	24.03	42.35	33.62	.74
	222	29.40	52.42	18.18	.68	31.56	55.60	12.84	29	46	.69	.....	24	23.52	34.94	41.54	.66
8	217	28.78	54.17	17.05	.73	30.24	57.73	12.03	29	44	.74	.....	19	21.44	37.00	41.56	.91
	225	28.78	54.17	17.05	.73	30.21	57.57	12.22	28	46	.58	21	40	19.66	36.38	43.96	1.35
	226	28.78	54.17	17.05	.73	30.38	57.24	12.38	27	47	.61	16	38	21.33	34.95	43.72	1.09
	227	28.78	54.17	17.05	.73	31.25	57.14	11.61	32	48	.69	5	29	22.05	41.52	36.43	.87
9	220	36.68	47.12	16.20	.77	36.10	49.23	14.67	9	25	.66	14	29	26.26	33.56	40.18	.69
	223	36.68	47.12	16.20	.77	35.73	48.84	15.43	5	24	.60	22	38	28.01	36.84	35.15	.78
	224	36.68	47.12	16.20	.77	37.53	50.52	11.95	26	43	.78	.....	22	25.05	34.12	40.83	.77
	229	36.68	47.12	16.20	.77	35.71	49.06	15.23	6	22	.66	14	29	35.29	22.32	42.39	1.07
10	219	32.26	48.12	19.62	.76	34.61	52.72	12.67	35	49	.68	11	29	27.60	39.86	32.54	.71
	221	32.26	48.12	19.62	.76	34.38	53.57	12.05	39	51	.61	20	36	25.41	30.01	44.58	.76
11	228	34.08	46.56	19.36	.64	37.42	49.12	13.46	30	52	.61	5	36	27.64	42.20	30.16	.88
	230	34.08	46.56	19.36	.64	37.32	48.91	13.77	29	41	.58	9	25	26.68	33.49	39.83	.65
	231	34.08	46.56	19.36	.64	37.06	49.53	13.41	31	45	.64	.....	20	28.86	32.28	38.86	.74

[a] Washed coal from test 212 rewashed.
[b] Refuse from test 213 recrushed and rewashed.

Raw coal float-and-sink tests at Denver, Colo., 1907–8.

Denver No.	Maximum size of coal.	Specific gravity of solution used.	Percentage of— Float.	Percentage of— Sink.	Float coal analyses, dry basis. Ash.	Float coal analyses, dry basis. Sulphur.
1	2½ inches	1.35	49	51	7.83	0.71
		1.40	67	33	11.08	.63
		1.45	67	33	12.77	.56
	1 inch	1.35	52	48	8.00	.62
		1.41	70	30	10.31	.66
		1.45	80	20	11.43	.65
2	2½ inches	1.35	36	64	8.17	.74
		1.40	71	29	10.18	.72
		1.44	76	24	11.34	.67
	1 inch	1.35	53	47	8.10	.68
		1.41	68	32	9.48	.70
		1.45	72	28	10.29	.73
3	2½ inches	1.35	69	31	8.37	.59
		1.40	77	23	10.91	.72
		1.45	83	17	11.60	.61
	1 inch	1.35	61	39	9.70	.75
		1.40	81	19	10.58	.66
		1.45	87	13	11.01	.71
4	2½ inches	1.40	76	24	8.56	.61
		1.45	91	9	8.88	.53
		1.50	78	22	8.91	.53
	1 inch	1.40	80	20	7.15	.52
		1.45	87	13	7.90	.54
		1.50	91	9	8.87	.51
5	Run of mine	1.40	52	48	9.89	1.06
		1.48	62	38	11.94	.63
		1.58	67	33	14.75	.59
6	Nut	1.40	60	40	9.68	1.05
		1.49	87	13	13.83	.76
		1.59	95	5	13.46	1.17
	1 inch	1.40	71	29	9.76	.87
		1.48	83	17	10.72	1.03
		1.58	91	9	12.11	.92
7	Run of mine	1.40	80	20	10.36	0.71
		1.46	81	19	11.76	.68
		1.60	88	12	13.99	.69
8	2½ inches	1.40	82	18	12.08	.68
		1.50	86	14	12.23	.71
		1.59	96	4	12.69	.59
	1 inch	1.40	82	18	10.50	.81
		1.50	89	11	12.16	.64
		1.59	92	8	13.09	.67
9	2½ inches	1.40	79	21	11.68	.65
		1.48	74	26	11.35	.70
		1.58	93	7	13.04	.70
	1 inch	1.40	74	26	9.44	.71
		1.48	81	19	9.92	.65
		1.58	89	11	11.62	.65
10	Slack	1.40	83	17	11.33	.69
		1.50	86	14	10.45	.67
		1.52	83	17	11.14	.64
11	2 inches	1.35	58	42	10.25	.61
		1.45	73	27	12.53	.66
		1.56	80	20	13.44	.66
	¾ inch	1.34	57	43	9.44	.69
		1.45	74	26	12.30	.51
		1.55	80	20	13.92	.61

Refuse float-and-sink tests at Denver, Colo., 1907–8.

Denver No.	Refuse from washing test No.—	Specific gravity of solution used.	Percentage of—		Float coal analyses, dry basis.	
			Float.	Sink.	Ash.	Sulphur.
1	200	1.35	23	77	8.71	0.63
		1.40	29	71	10.65	.79
		1.45	34	66	12.74	.61
	210	1.40	26	74	11.80	.82
		1.48	38	62	15.39	.62
		1.59	39	61	18.26	.68
2	201	1.35	36	64	7.37	.73
		1.40	39	61	9.47	.75
		1.45	47	53	11.82	.76
	204	1.40	27	73	8.88	.84
		1.45	28	72	10.10	.77
		1.50	28	72	9.91	.71
	209	1.45	31	69	11.49	.73
		1.50	35	65	12.73	.71
		1.55	40	60	14.89	1.06
3	202	1.40	40	60	8.15	.72
		1.45	48	52	9.91	.70
		1.50	50	50	11.29	.74
	205	1.40	30	70	8.74	.75
		1.45	36	64	11.49	.72
		1.50	38	62	13.56	.69
4	203	1.50	37	63	6.96	.51
		1.51	38	62	10.09	.51
		1.55	46	54	11.44	.53
	206	1.45	68	32	8.29	.49
		1.55	72	28	10.33	.47
		1.58	75	25	11.40	.55
	208	1.43	53	47	8.49	.58
		1.50	55	45	9.44	.43
		1.55	55	45	12.00	.44
5	207	1.40	17	83	10.49	.59
		1.47	22	78	12.80	.60
		1.58	25	75	18.87	.55
	211	1.40	32	68	9.39	.64
		1.50	36	64	12.46	.68
		1.61	39	61	16.23	.62
	212	1.40	34	66	11.08	.66
		1.50	40	60	14.29	.48
		1.60	42	58	17.52	.70
	212 *a*	1.38	55	45	10.24	.72
		1.48	57	43	10.71	.63
		1.59	65	35	14.38	.63
6	213	1.40	65	35	8.65	.73
		1.49	80	20	13.10	.65
		1.58	87	13	12.84	.66
	213 *a*	1.38	34	66	8.54	.84
		1.48	49	51	13.28	.81
		1.59	59	41	19.97	.97
	214	1.43	51	49	10.70	.81
		1.56	61	39	14.68	.82
		1.64	69	31	17.00	1.00
	215	1.40	33	67	11.37	1.05
		1.50	51	49	15.23	.89
		1.60	69	31	22.20	.97
7	216	1.42	40	60	14.33	0.82
		1.51	44	56	17.90	.81
		1.61	57	43	21.94	.68
	218	1.41	27	73	10.63	.75
		1.50	43	57	19.74	.68
		1.61	56	44	24.81	.68
	222	1.42	33	67	13.06	.69
		1.51	44	56	18.35	.74
		1.61	56	44	25.19	.59
8	217	1.43	31	69	14.13	.69
		1.52	38	62	20.35	.67
		1.63	66	34	24.94	1.10
	225	1.40	23	77	10.33	.68
		1.50	26	74	14.78	.70
		1.60	33	67	23.50	.81
	226	1.41	30	70	12.29	.54
		1.49	37	63	16.72	.73
		1.60	44	56	22.92	.59
	227	1.42	26	74	13.77	.63
		1.50	38	62	20.27	.67
		1.60	51	49	25.68	.58
9	220	1.40	27	73	9.34	.63
		1.50	43	57	13.29	.58
		1.60	52	48	20.02	.63
	223	1.40	32	68	9.54	.70
		1.50	41	59	15.96	.62
		1.60	52	48	17.49	.70
	224	1.40	29	71	9.29	.73
		1.50	44	56	20.97	.64
		1.60	65	35	27.63	.67
	229	1.39	21	79	9.50	.58
		1.49	25	75	11.46	.66
		1.57	38	62	23.29	.62
10	219	1.40	40	60	10.38	.57
		1.49	42	58	11.09	.59
		1.60	50	50	13.51	.54
	221	1.40	33	67	11.94	.68
		1.49	35	65	14.84	.56
		1.60	45	55	19.95	.56
11	228	1.40	44	56	12.28	.55
		1.50	55	45	16.54	.61
		1.60	67	33	21.31	.55
	230	1.40	27	73	12.71	.72
		1.50	45	55	19.24	.73
		1.60	55	45	26.07	.51
	231	1.40	34	66	12.67	.61
		1.50	43	57	18.20	.56
		1.60	55	45	21.10	.56

[a] See notes under table showing washing tests.

Crushing tests at Denver, Colo., 1907–8.

Denver No.	Crusher used.	Distance between rolls.	Percentage of coal passing screen.						
			Over 1¼ inches.	Through 1¼ inches and over 1 inch.	Through 1 inch and over ¾ inch.	Through ¾ inch and over ½ inch.	Through ½ inch and over ⅜ inch.	Through ⅜ inch and over ¼ inch.	Through ¼ inch.
1	24 by 30 inch corrugated-roll disintegrator.	⅝ inch		5	13	25	12	20	25
2	do	do		7	16	19	10	15	33
3	do	do			11	26	11	19	33
4	do	do		2	10	32	14	21	21
5		Run of mine			2	6	5	10	77
6	24 by 30 inch corrugated-roll disintegrator.	⅝ inches		2	13	40	15	18	12
6		Nut	36	19	18	14	3	3	7
7		Run of mine	12	10	11	18	9	14	26
8	18 by 24 inch tooth-roll crusher.	5 inches [a]	14	11	13	19	8	13	22
8	24 by 30 inch corrugated-roll disintegrator.	1 inch		2	12	27	13	19	27
9	do	do	2	6	28	32	12	11	9
9	do	½ inch			10	31	15	20	24
9	18 by 24 inch tooth-roll crusher.	5 inches [a]	18	13	14	19	7	11	18
10		Slack			8	20	11	16	45
11	24 by 30 inch corrugated-roll disintegrator.	1 inch		8	22	26	11	12	21
11	18 by 24 inch tooth-roll crusher.	5 inches [a]	11	11	13	19	9	14	23

[a] From face to face of rolls, not tooth ends. Teeth are 2¼ inches long.

CONCLUSIONS.

The washing tests of Denver No. 1 were not satisfactory when compared with the raw-coal float-and-sink tests, which indicate that a much better separation is possible. However, the best of this coal is of a high specific gravity and would require careful washing to obtain a good separation.

A similar statement applies to the tests on Denver No. 2.

The tests on Denver No. 3 were much more satisfactory, as the percentage of refuse was not so great and the loss of good coal in the refuse was not high.

The tests made on Denver No. 4 indicate clearly the value of the float-and-sink tests on the refuse. It will be noted that the percentage of refuse was increased with each test, yet nothing was gained so far as the reduction of ash in the washed coal was concerned. However, by referring to the "Loss of good coal" column it is found that this loss increased steadily as the refuse was increased, which goes to show that most of the additional "refuse" was good coal only. In proof of this the following figures are exceedingly interesting:

(*a*) Test 203; refuse 10 per cent.
(*b*) Test 206; refuse 18 per cent.
(*c*) Test 208; refuse 27 per cent.
(*d*) Difference between a and $b = 8$ per cent.
(*e*) Difference between a and $c = 17$ per cent.

Of the refuse from test—

203, (f) 38 per cent floated as good coal; (g) 62 per cent sank as pure refuse.
206, (h) 72 per cent floated as good coal; (i) 28 per cent sank as pure refuse.
208, (k) 55 per cent floated as good coal; (l) 45 per cent sank as pure refuse.

These percentages, converted to percentages of the original raw-coal sample, are as follows:

38 (f) $\times$ 10 (a) = 3.8, say 4 per cent (m).
62 (g) $\times$ 10 (a) = 6.2, say 6 per cent (n).
$m + n$ = 10 per cent = refuse (a) in test 203.
72 (h) $\times$ 18 (b) = 12.96, say 13 per cent (o).
28 (i) $\times$ 18 (b) = 5.04, say 5 per cent (p).
$o + p$ = 18 per cent = refuse (b) in test 206.
55 (k) $\times$ 27 (c) = 14.85, say 15 per cent (q).
45 (l) $\times$ 27 (c) = 12.15, say 12 per cent (r).
$q + r$ = 27 per cent = refuse (c) in test 208.

If the 8 per cent (d) additional refuse in test 206 over that of test 203 was all good coal, then 8 (d) + 4 (m) should equal o, or 13 per cent. However, as it is less than 13 per cent by 1 per cent, this would indicate that the additional 8 per cent (d) refuse was all good coal, but that the amount of refuse matter removed in test 206 was less than was removed in test 203. The sink of 5 per cent (p) from the refuse of test 206 would substantiate this inference, for it is found to be 1 per cent less than the sink from the refuse of test 203, which was 6 per cent (n). The chemical analyses of the washed coals also bear out this assumption, for the ash is slightly higher in that of test 206 than it is in that of test 203. The refuse analyses also substantiate this theory.

If it is assumed that all of the additional refuse—17 per cent (e)—in test 208 was also good coal, then 17 (e) + 4 (m) should equal q, or 15 per cent. However, it exceeds q by 6 per cent, and this excess must therefore have been refuse matter. To prove this: The pure refuse in test 203 was 6 per cent (n); by adding to this the above excess of 6 per cent refuse matter we have 12 per cent, which should equal the pure refuse (r) if the assumption is true.

It appears, therefore, that all the additional refuse [8 per cent (d)] in test 206 was simply good coal and that no additional refuse matter was removed by increasing the amount of refuse in washing. It also appears that of the additional refuse [17 per cent (e)] in test 208, a part was pure refuse matter, this amount being equal to 6 per cent of the original raw-coal sample. 17 per cent (e) − 6 per cent (excess) = 11 per cent. As 11 is 65 per cent of 17, it appears that 65 per cent of the additional refuse was good coal.

These figures prove conclusively that it is only a loss to increase the refuse above 10 per cent in washing this coal.

Denver No. 5, as received, was run-of-mine coal, but by referring to the table of crushing tests it will be seen that there was no lump coal and that 77 per cent of it passed through a $\frac{1}{4}$-inch screen. It therefore appears that this coal requires very careful washing, and that great care should be taken in designing a plant to wash it. From the raw-coal float-and-sink tests it appears that the ash may be greatly reduced, but to do so a very high percentage of the coal must be discarded as refuse. Probably 50 per cent would give the best results, but the demand for this coal and the valuation that could be placed on the washed coal would determine whether the operator could afford to throw away so great a percentage to obtain a coal of such resulting quality.

Denver No. 6 was of a nut size as received and was to be washed for household coal only and not for coking purposes. Therefore it was not to be crushed either before or after washing, though some tests were made with finer crushing as a matter of experiment. The test on the Stewart jig was not satisfactory, and as this machine is old and in bad condition it was decided not to make further use of it until it could be remodeled. Tests were therefore made on the special jig, but the results were not satisfactory, as the coal was a little too large for this machine to handle. The raw-coal float-and-sink tests, however, show that the coal can be successfully washed with proper facilities.

The washing tests on Denver No. 7 were not very successful, but the float-and-sink tests indicate a possibility of a fair separation. Attention must be given to the high specific gravity of the coal when considering machines for washing it.

In all four of the washing tests on Denver No. 8 the ash in the washed coal remained about the same, though different percentages of refuse were tried. When considered in conjunction with the raw-coal float-and-sink tests it would seem that 12 per cent is as low as the ash can be reduced and that nothing is gained by crushing the coal below a maximum size of $2\frac{1}{2}$ inches nor by discarding over 8 per cent as refuse.

All the tests on Denver No. 9 strongly indicate that a comparatively fine crushing is necessary to obtain the best results, probably to about $\frac{1}{2}$ inch being the best. About 20 per cent refuse would give the best results, though by careful attention to the operation of the plant at all times this may possibly be cut to 15 per cent or a little less.

Denver No. 10, being a slack coal, with the percentage of fines fairly high, will require careful attention in washing. A good reduction of the ash can be made and the amount of refuse possibly cut to 14 per cent.

Both the washing tests and the float-and-sink tests on Denver No. 11 indicate no particular gain in crushing this coal below a maximum size of 2 inches and no gain in the quality of the washed coal by increasing the refuse above 18 per cent.

The loss of good coal in nearly every test was higher than it should be. It was found that in all tests except Nos. 213 and 215, on Denver No. 6, about 80 to 90 per cent of the good coal lost was very fine coal—so fine, in fact, that the least agitation of the water in the sludge tank kept it in suspension. The sludge tank is comparatively small, and the inflowing water from the jigs keeps the water in it boiling continually. This tank can not be made larger without extending the building, but it is hoped that arrangements may soon be made to lengthen the tank to 35 or 40 feet. With such a tank nearly all of the fine coal can be caught and sent over with the washed coal. At present this fine coal in suspension overflows to the pump sump and is then pumped back to the jigs beneath the jig screen; in that way it becomes mixed with the refuse.

Another improvement hoped for is the installation of a water-supply tank to deliver the water to the jigs. In this way a constant pressure, which is essential to the best operation of the jigs, would be maintained. With the present arrangement the flow varies greatly and the best results can not be obtained.

COKING TESTS.

By A. W. Belden.

EQUIPMENT.

The coking tests were conducted in a battery of two beehive ovens, one 7 feet high by 12 feet in diameter, the other 6 feet 3 inches high by 12 feet in diameter. A standard larry of 8 tons capacity and the necessary scales for accurate weighing of coal charged and coke produced completed the equipment.

PROCEDURE OF TESTS.

The coal for the first seven tests was crushed through a roll crusher to about ½-inch size. Beginning with Test 202 and throughout the remainder of the work all coal was finely crushed through a Pennsylvania hammer crusher, unless otherwise stated in the detailed report of the tests. The coals put through the hammer crusher varied somewhat, but the average, taken from a large number of samples, was as follows: Through ⅛-inch mesh, 100 per cent; over 10-mesh, 31.43 per cent; over 20-mesh, 24.29 per cent; over 40-mesh, 22.86 per cent; over 60-mesh, 11.42 per cent; through 60-mesh, 10 per cent. The sampling of coal and coke and the handling of the ovens were practically the same as described in Survey Bulletin No. 336,[a] from which the following is quoted:

> Both the door and the trunnel head of the oven were always closed directly after the oven was drawn and it was allowed to gather heat, the length of time varying as necessity demanded. The average time was one and one-half hours.

[a] Moldenke, Richard, Belden, A. W., and Delamater, G. R., Washing and coking tests of coal and cupola tests of coke: Bull. U. S. Geol. Survey No. 336, 1908, p. 19.

The sample of coal was taken at regular intervals, as the charge was emptied from bin to larry, by means of a small shovel holding about one-fourth pound. The total weight of the sample averaged 45 pounds.

The sample of coke was taken from five different parts of the oven, as nearly as possible from the same location for each test, as follows: 2 feet from the oven door; 2 feet from each side, on a line drawn from the center of the oven; at the center; and 2 feet from the back wall, on a line with the point of selection of the pieces taken from the door and the center. The separate pieces of coke extended the whole height of the charge and were as nearly uniform in size as possible.

EXTENT OF TESTS.

From November 30, 1907, to March 21, 1908, 52 tests were made on 14 coals from three States and one Territory, as shown in the following tables. Of these tests 10 were made on raw coal, 38 on washed coal, and 4 on mixtures of raw and washed coal. Of the 14 different coals three, viz, Nos. 6, 12, and 13, produced no coke, whether tested washed or raw, crushed or not crushed.

TABULATION OF RESULTS.

The results of the coking tests will be found in the detailed report on each sample, presented herewith. The former method of stating yield of dry coke from dry coal, coke as received from coal as charged, and all other items has been continued. The percentage of coke remaining on a screen with 2-inch mesh, after four consecutive 6-foot drops without intermediate screening, is given in the last item under "Physical properties of coke." It was decided to make the phosphorus determination on each coke produced in order that a better average might be obtained. "Cell structure" refers to the general appearance as to size and not to the number of cells as given by percentage of cells by volume. In many tests the cell structure as determined from general appearance is small, when the percentage by volume indicates quite the reverse. The following abbreviations are used in the tables:

f. c., finely crushed.
n. c., not crushed.
r., raw.
r. o. m., run of mine.
sl., slack.
w., washed.

DENVER No. 1.

Coking tests.

	Test 195.		Test 195.
Date	12, 2, 07	Physical properties of coke:	
Duration .... hours..	64	Specific gravity—	
Size:		Apparent	1.05
As shipped	r. o. m.	Real	1.92
As used	½ in.	Volume—	
Coal charged:		Coke .... per cent..	55.00
Wet .... pounds..	13,310	Cells .... do....	45.00
Dry .... do....	12,868	Weight per cubic foot—	
Coke produced:		Wet .... pounds..	93.08
Wet .... do....	9,000	Dry .... do....	65.00
Wet .... per cent..	67.62	6-foot drop test over 2-inch mesh—	
Dry .... pounds...	8,932	1 .... per cent..	93.00
Dry .... per cent..	69.41	2 .... do....	86.00
Breeze produced:		3 .... do....	81.00
Wet .... pounds...	528	4 .... do....	76.50
Wet .... per cent..	3.97	5 .... do....	86.00
Dry .... pounds...	524		
Dry .... per cent..	4.07		
Total yield:			
Wet .... do....	71.59		
Dry .... do....	73.48		

Remarks.—Test No. 195: Light-gray color with some little silvery coloration. Breakage good; long, large pieces. Cell structure, a little large. Metallic ring.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
195	124-D	Coal, Wet	3.32	31.99	51.96	12.73	0.61	....
		Coal, Dry	....	33.08	53.75	13.17	.63	....
	130-D	Coke, Wet	.76	1.23	77.48	20.53	.44	0.0235
		Coke, Dry	....	1.24	78.07	20.69	.44	....

DENVER No. 2.

Coking tests.

	Test 196.	Test 197.	Test 205.
Date	12, 5, 07	12, 10, 07	1, 4, 08
Duration ... hours	67	99	37
Size:			
As shipped	r. o. m.	r. o. m.	r. o. m.
As used	½ in.	½ in.	w., f. c.
Coal charged:			
Wet ... pounds	13,050	17,200	10,970
Dry ... do	12,317	16,240	10,606
Coke produced:			
Wet ... do	8,320	11,258	7,380
Wet ... per cent	63.75	65.45	67.27
Dry ... pounds	8,218	11,203	7,345
Dry ... per cent	66.72	68.98	69.25
Breeze produced:			
Wet ... pounds	515	689	337
Wet ... per cent	3.95	4.01	3.07
Dry ... pounds	509	686	335
Dry ... per cent	4.13	4.22	3.16
Total yield:			
Wet ... do	67.70	69.46	70.34
Dry ... do	70.85	73.20	72.41
Physical properties of coke:			
Specific gravity—			
Apparent	1.09	1.05	1.00
Real	1.90	1.93	1.93
Volume—			
Coke ... per cent	57.00	54.00	52.00
Cells ... do	43.00	46.00	48.00
Weight per cubic foot—			
Wet ... pounds	93.92	93.87	92.01
Dry ... do	67.09	65.19	62.06
6-foot drop test over 2-inch mesh—			
1 ... per cent	91.50	95.50	93.00
2 ... do	83.00	89.50	90.50
3 ... do	78.00	82.50	86.00
4 ... do	70.00	74.50	83.50
5 ... do	76.50	79.50	88.50

Remarks.—Test No. 196: Light gray and silvery. Cell structure a little large Breakage good; long, large pieces.

Test No. 197: Light gray and silvery; large deposit of carbon. Cell structure good. Breakage good; long, large pieces. Good, heavy coke.

Test No. 205: Light gray and silvery; large deposit of carbon. Cell structure good. Breakage good; long, large pieces. Metallic ring. Good, heavy coke.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
196	131-D	Coal, Wet	5.61	30.23	48.84	15.32	0.74	
		Coal, Dry		32.02	51.75	16.23	.78	
	145-D	Coke, Wet	1.23	3.21	72.94	22.62	.54	0.0175
		Coke, Dry		3.25	73.84	22.91	.56	
197	142-D	Coal, Wet	5.58	30.25	49.46	14.71	.75	
		Coal, Dry		32.03	52.39	15.58	.79	
	154-D	Coke, Wet	.49	1.43	77.40	20.88	.72	.0102
		Coke, Dry		1.44	77.77	20.79	.72	
205	207-D	Coal, Wet	3.32	31.08	49.90	15.70	.72	
		Coal, Dry		32.15	51.60	16.25	.75	
	209-D	Coke, Wet	.47	.46	77.10	21.97	.66	.0217
		Coke, Dry		.46	77.46	22.08	.66	

DENVER No. 3.

Coking tests.

	Test 198.	Test 199.		Test 198.	Test 199.
Date	12,13,07	12,17,07	Physical properties of coke:		
Duration.......hours	54	71	Specific gravity—		
Size:			Apparent	0.97	1.02
As shipped	r. o. m.	r. o. m.	Real	1.89	1.92
As used	½ in.	½ in.	Volume—		
Coal charged:			Coke.......per cent	51.00	53.00
Wet.......pounds	12,200	14,110	Cells.......do	49.00	47.00
Dry.......do	11,625	13,412	Weight per cubic foot—		
Coke produced:			Wet.......pounds	90.82	92.81
Wet.......do	7,800	8,900	Dry.......do	60.27	63.51
Wet.......per cent	63.93	63.08	6-foot drop test over 2-inch mesh—		
Dry.......pounds	7,770	8,884			
Dry.......per cent	66.84	66.24	1.......per cent	95.00	98.00
Breeze produced:			2.......do	87.50	91.50
Wet.......pounds	387	464	3.......do	81.50	86.50
Wet.......per cent	3.17	3.29	4.......do	72.50	79.50
Dry.......pounds	386	463	5.......do	79.50	86.00
Dry.......per cent	3.32	3.45			
Total yield:					
Wet.......do	67.10	66.37			
Dry.......do	70.16	69.69			

Remarks.—Test No. 198: Light gray and silvery. Cell structure good. Breakage good; long, large pieces. Metallic ring. Good coke.

Test No. 199: Light gray and silvery; large deposit carbon. Cell structure small, but not dense. Metallic ring. Breakage good; long, large pieces. Good, heavy coke.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
198	153-D	Coal, Wet	4.71	30.95	51.51	12.83	0.67	
		Coal, Dry		32.48	54.05	13.47	.70	
	162-D	Coke, Wet	.38	.48	80.94	18.20	.57	0.0127
		Coke, Dry		.48	81.25	18.27	.57	
199	161-D	Coal, Wet	4.95	31.39	51.85	11.81	.71	
		Coal, Dry		33.03	54.55	12.42	.75	
	169-D	Coke, Wet	.18	.29	81.99	17.54	.59	.0146
		Coke, Dry		.29	82.15	17.56	.59	

DENVER No. 4.

Coking tests.

	Test 200.	Test 201.	Test 202.	Test 203.	Test 204.
Date	12,19,07	12,22,07	12,26,07	12,30,07	1,2,08
Duration ... hours	38	34	52	54	46
Size:					
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	w., $\frac{5}{8}$ in.	w., $\frac{5}{8}$ in.	w., f. c.	w., f. c.	w., f. c.
Coal charged:					
Wet ... pounds	9,990	10,370	13,450	12,970	11,630
Dry ... do	9,463	9,639	12,751	12,044	10,659
Coke produced:					
Wet ... do	5,853	5,450	7,310	7,650	6,900
Wet ... per cent	58.59	52.56	54.35	58.98	59.33
Dry ... pounds	5,806	5,382	7,303	7,596	6,868
Dry ... per cent	61.35	55.84	57.27	63.07	64.43
Breeze produced:					
Wet ... pounds	588	674	492	585	420
Wet ... per cent	5.88	6.50	3.66	4.51	3.61
Dry ... pounds	583	666	492	581	418
Dry ... per cent	6.16	6.90	3.86	4.82	3.92
Total yield:					
Wet ... do	64.47	59.06	58.01	63.49	62.94
Dry ... do	67.51	62.74	61.13	67.89	68.35
Physical properties of coke:					
Specific gravity—					
Apparent	.95	.96	.96	.98	.94
Real	1.90	1.87	1.87	1.86	1.87
Volume—					
Coke ... per cent	50.00	51.00	51.00	53.00	50.00
Cells ... do	50.00	49.00	49.00	47.00	50.00
Weight per cubic foot—					
Wet ... pounds	89.95	89.69	90.41	89.99	89.57
Dry ... do	58.75	59.13	59.86	60.69	58.37
6-foot drop test over 2-inch mesh—					
1 ... per cent	92.00	91.50	94.00	94.50	96.50
2 ... do	86.00	88.00	90.50	90.00	91.50
3 ... do	81.50	78.00	86.00	86.50	86.00
4 ... do	78.00	74.00	82.00	81.00	81.50
5 ... do	79.50	85.00	83.50	84.50	86.50

Remarks.—Test No. 200: Light gray and silvery. Cell structure small; not dense. Breakage somewhat marred by cross fracture, but pieces of good size. Somewhat brittle and fingered.

Test No. 201: Light gray and silvery; large deposit carbon. Cell structure small, not dense. Somewhat brittle and soft. Fingered.

Test No. 202: Fingered. Dark lower portion; light gray and silvery upper $\frac{3}{4}$. Cell structure and breakage same as No. 201.

Test No. 203: Fingered. Dark coloration, but large deposit carbon. Cell structure and breakage same as No. 201. Metallic ring. Good heavy coke.

Test No. 204: Same as No. 203.

High phosphorus of this coke noticeable in all tests.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
200	168-D	Coal	Wet	5.28	34.95	50.54	9.23	0.47	
			Dry		36.90	53.36	9.74	.50	
	171-D	Coke	Wet	.81	1.01	82.95	15.23	.48	0.1737
			Dry		1.02	83.64	15.34	.48	
201	170-D	Coal	Wet	7.05	33.39	49.73	9.83	.51	
			Dry		35.92	53.50	10.58	.55	
	198-D	Coke	Wet	1.25	1.11	82.48	15.16	.56	.1824
			Dry		1.12	83.51	15.37	.57	
202	199-D	Coal	Wet	5.20	34.61	51.58	8.61	.48	
			Dry		36.51	54.42	9.07	.51	
	200-D	Coke	Wet	.09	.14	85.56	14.21	.48	.1737
			Dry		.14	85.64	14.22	.48	
203	204-D	Coal	Wet	7.14	34.09	49.96	8.81	.50	
			Dry		36.72	53.79	9.49	.54	
	206-D	Coke	Wet	.70	1.62	82.69	14.99	.47	.1912
			Dry		1.63	83.27	15.10	.47	
204	205-D	Coal	Wet	8.35	33.19	49.42	9.04	.50	
			Dry		36.21	53.93	9.86	.55	
	208-D	Coke	Wet	.46	.12	84.80	14.62	.45	.1898
			Dry		.12	85.19	14.69	.45	

DENVER No. 5.

Coking tests.

	Test 207.	Test 208.	Test 212.	Test 213.
Date	1,10,08	1,12,08	1,27,08	1,29,08
Duration ... hours	55	34	37	50
Size:				
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	w., f. c.	w., f. c.	w., f. c.	w., n. c.
Coal charged:				
Wet ... pounds	10,560	8,660	8,230	4,950
Dry ... do	9,611	7,903	7,591	4,474
Coke produced:				
Wet ... pounds	5,780	3,900	4,437	2,100
Wet ... per cent	54.73	45.04	53.91	42.42
Dry ... pounds	5,750	3,893	4,417	2,042
Dry ... per cent	59.83	49.26	58.19	45.64
Breeze produced:				
Wet ... pounds	1,412	1,170	720	944
Wet ... per cent	13.37	13.51	8.75	19.07
Dry ... pounds	1,405	1,168	717	918
Dry ... per cent	14.62	14.78	9.44	20.52
Total yield:				
Wet ... do	68.10	58.55	62.66	61.49
Dry ... do	74.45	64.04	67.63	66.16
Physical properties of coke:				
Specific gravity—				
Apparent	.92	.92	.85	1.03
Real	1.88	1.87	1.87	1.89
Volume—				
Coke ... per cent	49.00	49.00	45.00	54.00
Cells ... do	51.00	51.00	55.00	46.00
Weight per cubic foot—				
Wet ... pounds	88.89	89.08	87.06	91.14
Dry ... do	57.07	57.26	52.77	62.45
6-foot drop test over 2-inch mesh—				
1 ... per cent	85.00	86.00	95.50	80.50
2 ... do	73.00	74.00	90.00	61.00
3 ... do	62.00	61.50	83.00	48.50
4 ... do	54.50	53.50	76.00	35.50
5 ... do	74.00	65.50	80.50	47.50

Remarks.—Test No. 207: Dull-gray color. No apparent cell structure. Not coked down to bottom. Large amount of breeze and high volatile in coke probably due to this. Soft, punky, dense coke. Impossible to wash coal enough to reduce ash of coke within allowed limits.

Test No. 208: Same as 207.

Test No. 212: Rewashing of washed coal reduced ash content of coke to 22.07 per cent and reduced percentage of breeze, but did not materially better coke.

Test No. 213: Attempt to improve rewashed charge of 212 by not crushing. Breeze very much increased and cross fracture of coke more highly pronounced.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
207	229-D	Coal	Wet	8.99	32.33	40.34	18.34	0.55	
			Dry		35.53	44.31	20.16	.61	
	235-D	Coke	Wet	.52	1.42	71.94	26.12	.56	0.0177
			Dry		1.43	72.31	26.26	.56	
208	234-D	Coal	Wet	8.74	32.11	40.58	18.57	.59	
			Dry		35.18	44.47	20.35	.64	
	236-D	Coke	Wet	.18	1.26	70.60	27.96	.51	.0175
			Dry		1.26	70.73	28.01	.51	
212	253-D	Coal	Wet	7.76	33.97	44.11	14.16	.55	
			Dry		36.83	47.82	15.35	.60	
	265-D	Coke	Wet	.46	2.00	75.47	22.07	.55	.0100
			Dry		2.01	75.82	22.17	.55	
213	263-D	Coal	Wet	9.61	33.00	42.34	15.05	.46	
			Dry		36.50	46.85	16.65	.51	
	266-D	Coke	Wet	2.78	2.03	74.13	21.06	.58	.0125
			Dry		2.09	76.25	21.66	.60	

DENVER No. 6.

Coking tests.

	Test 209.	Test 210.	Test 211.	Test 214.
Date	1,19,08	1,20,08	1,22,08	1,30,08
Duration ... hours	80	36	43	60
Size:				
As shipped	nut	nut	nut	nut
As used	w., f. c.	w., f. c.	w., ⅝ in.	r., ⅝ in.
Coal charged:				
Wet ... pounds	10,220	7,730	9,520	9,790
Dry ... do	9,569	7,238	8,729	9,198
Coke produced	None.	None.	None.	None.

Remarks.—Test No. 209: Charge burned very rapidly, but developed no cracks. At no stage was there any evidence of pasty condition or other signs of coking.

Test No. 210: Charge burned with small draft and exhibited only few widely separated cracks. Volatile driven off, but resultant product did not stick together.

Test No. 211: Effort to coke not crushed. Volatile driven off down about 12 inches and under this unburned coal.

Test No. 214: This test made to ascertain if washing might possibly have destroyed coking qualities. Volatile driven off as in Test No. 211, no evidence of coking.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile. matter.	Fixed carbon.	Ash.	Sulphur.
209, 210	241-D	Coal	Wet	6.37	37.11	44.57	11.95	0.89
			Dry		39.63	47.61	12.76	.95
211	242-D	Coal	Wet	8.31	37.44	42.04	12.21	.84
			Dry		40.82	45.86	13.32	.92
214	240-D	Coal	Wet	6.05	35.45	39.64	18.86	1.04
			Dry		37.73	42.19	20.08	1.11

DENVER No. 7.

Coking tests.

		Test 215.	Test 216.	Test 221.
Date		1,31,08	2,2,08	2,12,08
Duration	hours	38	53	44
Size:				
As shipped		r. o. m.	r. o. m.	r. o. m.
As used		w., f. c.	w., f. c.	w., n. c.
Coal charged:				
Wet	pounds	10,990	13,000	12,000
Dry	do	10,484	12,379	11,423
Coke produced:				
Wet	do	7,650	8,909	8,367
	per cent	69.61	68.53	69.73
Dry	pounds	7,507	8,887	8,347
	per cent	71.60	71.79	73.07
Breeze produced:				
Wet	pounds	212	292	279
	per cent	1.93	2.25	2.32
Dry	pounds	208	291	278
	per cent	1.98	2.35	2.43
Total yield:				
Wet	do	71.54	70.78	72.05
Dry	do	73.58	74.14	75.50
Physical properties of coke:				
Specific gravity—				
Apparent		1.14	1.10	1.08
Real		1.93	1.96	1.93
Volume—				
Coke	per cent	59.00	56.00	56.00
Cells	do	41.00	44.00	44.00
Weight per cubic foot—				
Wet	pounds	95.33	95.86	94.64
Dry	do	69.76	68.43	67.21
6-foot drop test over 2-inch mesh—				
1	per cent	94.00	97.50	98.00
2	do	92.00	95.00	94.50
3	do	88.50	92.50	93.00
4	do	85.50	91.00	90.00
5	do	89.50	93.00	89.00

Remarks.—Test No. 215: Light gray and silvery color. Cell structure small. Breakage somewhat cross fractured, but pieces of good uniform size, 8-inch cubes. Metallic ring. Volatile in coke a little high, due to cold bottom. Good coke.

Test No. 216: Light gray and silvery color. Breakage same as 215. Cell structure very small, coke dense. Metallic ring. Very heavy, good coke. Volatile completely expelled.

Test No. 221: Light gray and silvery color, heavy deposit of carbon, probably cause of increased yield. Breakage good; long, large pieces. Metallic ring. Very heavy, good coke. Cells not so well closed as in coke from finely crushed coal.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
215	264-D	Coal, Wet	4.60	29.56	54.10	11.74	0.67	
		Coal, Dry		30.99	56.70	12.31	.70	
	268-D	Coke, Wet	1.87	.89	79.74	17.50	.60	0.0105
		Coke, Dry		.91	81.26	17.83	.61	
216	270-D	Coal, Wet	4.78	29.69	53.79	11.74	.79	
		Coal, Dry		31.18	56.49	12.33	.83	
	273-D	Coke, Wet	.25	.01	82.36	17.38	.60	.0116
		Coke, Dry		.01	82.57	17.42	.60	
221	301-D	Coal, Wet	4.81	29.86	52.47	12.86	.63	
		Coal, Dry		31.38	55.10	13.52	.66	
	335-D	Coke, Wet	.24	.49	82.49	16.78	.81	.0140
		Coke, Dry		.49	82.68	16.83	.61	

DENVER No. 8.

Coking tests.

	Test 226.	Test 227.	Test 228.
Date of test	2,17,08	2,20,08	2,23,08
Duration of test ... hours	36	52	64
Size:			
As shipped	r. o. m.	r. o. m.	r. o. m.
As used	w., f. c.	w., f. c.	w., f. c.
Coal charged:			
Wet ... pounds	10,020	12,000	12,890
Dry ... do	9,623	11,346	12,111
Coke produced:			
Wet ... do	7,112	8,502	9,145
Wet ... per cent	70.98	70.86	70.95
Dry ... pounds	7,099	8,492	9,118
Dry ... per cent	73.77	74.85	75.29
Breeze produced:			
Wet ... pounds	197	207	225
Wet ... per cent	1.97	1.73	1.74
Dry ... pounds	197	207	224
Dry ... per cent	2.05	1.82	1.85
Total yield:			
Wet ... do	72.95	72.58	72.69
Dry ... do	75.82	76.67	77.14
Physical properties of coke:			
Specific gravity—			
Apparent	1.08	1.06	1.02
Real	1.95	1.92	1.92
Volume—			
Coke ... per cent	55.00	55.00	53.00
Cells ... do	45.00	45.00	47.00
Weight per cubic foot—			
Wet ... pounds	95.33	94.11	92.74
Dry ... do	67.25	66.03	63.44
6-foot drop test over 2-inch mesh—			
1 ... per cent	98.50	97.00	98.50
2 ... do	97.50	95.00	95.50
3 ... do	95.00	92.50	93.00
4 ... do	92.50	90.50	90.00
5 ... do	93.50	93.50	93.50

Remarks.—Test No. 226: Light gray and silvery. Cell structure small. Metallic ring. Breakage somewhat cross-fractured and irregular, but pieces of good size. Very hard and dense.

Test No. 227: Same as No. 226.

Test No. 228: Same as 226 and 227, except yield is higher, due to increased volatile in coke, not burned as well as two preceding charges. All three gave large yield and good, hard coke.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
226	332-D	Coal, Wet	3.96	29.04	55.45	11.55	0.71	
		Coal, Dry		30.24	57.73	12.03	.74	
	343-D	Coke, Wet	.18	.49	82.23	17.10	.63	0.0143
		Coke, Dry		.49	82.38	17.13	.63	
227	336-D	Coal, Wet	5.45	28.57	54.43	11.55	.55	
		Coal, Dry		30.21	57.57	12.22	.58	
	348-D	Coke, Wet	.12	.40	82.10	17.38	.60	.0143
		Coke, Dry		.40	82.20	17.40	.60	
228	344-D	Coal, Wet	6.04	28.54	53.79	11.63	.59	
		Coal, Dry		30.38	57.24	12.38	.61	
	354-D	Coke, Wet	.29	1.27	81.03	17.41	.68	.0110
		Coke, Dry		1.27	81.27	17.46	.68	

DENVER No. 9.

Coking tests.

	Test 222.	Test 223.	Test 225.	Test 241.
Date	2,13,08	2,15,08	2,17,08	3,13,08
Duration ... hours	35	58	48	45
Size:				
As shipped	r.o.m.	r.o.m.	r.o.m.	r.o.m.
As used	w., f.c.	w., f.c.	w., f.c.	w., f.c.
Coal charged:				
Wet ... pounds	10,080	13,700	12,070	11,690
Dry ... do	9,687	13,133	11,544	11,349
Coke produced:				
Wet ... do	6,500	8,769	7,630	7,750
Wet ... per cent	64.48	64.01	63.21	66.30
Dry ... pounds	6,390	8,741	7,534	7,696
Dry ... per cent	65.96	66.56	65.26	67.81
Breeze produced:				
Wet ... pounds	262	393	362	405
Wet ... per cent	2.60	2.87	3.00	3.46
Dry ... pounds	258	392	357	402
Dry ... per cent	2.66	2.98	3.09	3.54
Total yield:				
Wet ... do	67.08	66.88	66.21	69.76
Dry ... do	68.62	69.54	68.35	71.35
Physical properties:				
Specific gravity—				
Apparent	1.03	1.02	.93	1.02
Real	1.90	1.90	1.89	1.93
Volume—				
Coke ... per cent	54.00	54.00	49.00	53.00
Cells ... do	46.00	46.00	51.00	47.00
Weight per cubic foot—				
Wet ... pounds	91.74	92.13	89.08	92.47
Dry ... do	63.06	63.44	57.26	63.17
6-foot drop test over 2-inch mesh—				
1 ... per cent	98.00	96.50	97.00	96.50
2 ... do	95.00	93.00	92.50	93.50
3 ... do	92.50	92.50	90.00	91.00
4 ... do	91.00	90.00	87.50	87.50
5 ... do	94.00	89.50	86.00	85.50

Remarks.—Test No. 222: Light gray and silvery, large deposit of carbon. Cell structure good. Good, metallic ring. Breakage good; long, large pieces. Fine, heavy coke.

Test Nos. 223, 225, and 241: Same as No. 222.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
222	302-D	Coal, Wet	3.90	34.69	47.29	14.12	0.63	
		Coal, Dry		36.10	49.23	14.67	.66	
	330-D	Coke, Wet	1.70	2.48	74.32	21.50	.57	0.0154
		Coke, Dry		2.52	75.61	21.87	.58	
223	303-D	Coal, Wet	4.14	34.47	47.95	13.44	.60	
		Coal, Dry		35.96	49.99	14.05	.63	
	333-D	Coke, Wet	.32	.81	79.07	19.80	.64	.0149
		Coke, Dry		.81	79.32	19.87	.64	
225	331-D	Coal, Wet	4.36	35.90	48.31	11.43	.75	
		Coal, Dry		37.53	50.52	11.95	.78	
	337-D	Coke, Wet	1.26	.96	78.89	18.89	.65	.0116
		Coke, Dry		.97	79.90	19.13	.65	
241	381-D	Coal, Wet	2.92	35.61	46.78	14.69	.80	
		Coal, Dry		36.68	48.19	15.13	.82	
	398-D	Coke, Wet	.70	.75	77.14	21.41	.48	.0163
		Coke, Dry		.76	77.68	21.56	.48	

DENVER No. 10.

Coking tests.

	Test 217.	Test 218.	Test 219.
Date	2,3,08	2,5,08	2,9,08
Duration .... hours	38	48	61
Size:			
As shipped	sl.	sl.	sl.
As used	w., f.c.	w., f.c.	w., f.c.
Coal charged:			
Wet .... pounds	9,940	12,350	14,290
Dry .... do	9,494	11,782	13,435
Coke produced:			
Wet .... do	6,450	7,547	8,860
Wet .... per cent	64.89	60.30	61.58
Dry .... pounds	6,413	7,480	8,703
Dry .... per cent	67.55	63.49	64.79
Breeze produced:			
Wet .... pounds	215	373	449
Wet .... per cent	2.16	3.02	3.14
Dry .... pounds	214	370	444
Dry .... per cent	2.25	3.14	3.30
Total yield:			
Wet .... do	67.05	63.32	64.72
Dry .... do	69.80	66.63	68.09
Physical properties of coke:			
Specific gravity—			
Apparent	1.04	1.02	.96
Real	1.91	1.89	1.94
Volume—			
Coke .... per cent	54.00	54.00	49.00
Cells .... do	46.00	46.00	51.00
Weight per cubic foot—			
Wet .... pounds	93.15	91.74	91.06
Dry .... do	64.47	63.06	59.25
6-foot drop test over 2-inch mesh—			
1 .... per cent	98.00	98.50	96.50
2 .... do	95.00	97.50	94.00
3 .... do	94.00	95.00	90.50
4 .... do	90.50	92.50	89.00
5 .... do	92.00	94.00	93.00

Remarks.—Test No. 217: Light gray and silvery. Cell structure good. Breakage good. Good, metallic ring. Good heavy coke. Charge ashed down about one-half inch over entire surface.

Test Nos. 218 and 219: Same as 217.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
217	269-D	Coal, Wet	4.49	33.06	50.35	12.10	0.65	
		Coal, Dry		34.61	52.72	12.67	.68	
	286-D	Coke, Wet	.57	.66	81.59	17.18	.57	0.0077
		Coke, Dry		.66	82.06	17.28	.57	
218	283-D	Coal, Wet	4.60	32.84	51.18	11.38	.58	
		Coal, Dry		34.42	53.65	11.93	.61	
	285-D	Coke, Wet	.89	.99	80.32	17.80	.57	.0091
		Coke, Dry		1.00	81.04	17.96	.58	
219	284-D	Coal, Wet	5.98	32.28	50.30	11.44	.57	
		Coal, Dry		34.34	53.49	12.17	.61	
	312-D	Coke, Wet	1.10	.82	81.09	16.99	.60	.0088
		Coke, Dry		.83	81.99	17.18	.61	

DENVER No. 11.

Coking tests.

	Test 230.	Test 236.	Test 240.
Date	2,26,08	3,4,08	3,10,08
Duration ... hours	34	53	51
Size:			
As shipped	r. o. m.	r. o. m.	r. o. m.
As used	w., f. c.	w., f. c.	w., f. c.
Coal charged:			
Wet ... pounds	9,700	13,270	13,800
Dry ... do	9,234	12,557	13,170
Coke produced:			
Wet ... do	5,934	9,168	9,540
Wet ... per cent	61.17	69.09	69.13
Dry ... pounds	5,872	9,088	9,526
Dry ... per cent	63.59	72.37	72.33
Breeze produced:			
Wet ... pounds	316	478	450
Wet ... per cent	3.26	3.60	3.26
Dry ... pounds	313	474	449
Dry ... per cent	3.39	3.78	3.41
Total yield:			
Wet ... do	64.43	72.69	72.39
Dry ... do	66.98	76.15	75.74
Physical properties of coke:			
Specific gravity—			
Apparent	.96	.97	1.06
Real	1.91	1.96	1.97
Volume—			
Coke ... per cent	50.00	49.00	54.00
Cells ... do	50.00	51.00	46.00
Weight per cubic foot—			
Wet ... pounds	90.45	91.78	94.64
Dry ... do	59.25	59.97	65.95
6-foot drop test over 2-inch mesh—			
1 ... per cent	98.50	97.00	98.00
2 ... do	97.50	93.50	96.00
3 ... do	94.00	92.00	94.50
4 ... do	90.50	89.50	92.00
5 ... do	94.50	91.50	94.50

Remarks.—Test No. 230: Light gray and silvery, some little deposited carbon. Cell structure a little small, not dense. Breakage good; large pieces. Metallic ring. Good, heavy coke.

Test No. 236: Light gray and silvery, good deposit carbon. Cell structure small, not dense. Breakage good; large pieces, more brittle than No. 230. Metallic ring. Good, heavy coke.

Test No. 240: Light gray and silvery, heavy deposit carbon. Cell structure good. Breakage good; long, large, heavy pieces, practically no cross fracture. Metallic ring. Fine coke.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
230	365-D	Coal	Wet	4.80	35.62	46.77	12.81	0.57	
			Dry		37.42	49.12	13.46	.61	
	362-D	Coke	Wet	1.05	1.66	78.02	19.27	.53	0.0416
			Dry		1.67	78.85	19.48	.53	
236	366-D	Coal	Wet	5.37	35.32	46.29	13.02	.55	
			Dry		37.32	48.91	13.77	.58	
	372-D	Coke	Wet	.87	1.02	77.56	20.55	.45	.0400
			Dry		1.03	78.25	20.72	.45	
240	377-D	Coal	Wet	4.56	35.37	47.27	12.80	.61	
			Dry		37.06	49.53	13.41	.64	
	380-D	Coke	Wet	.15	.35	79.18	20.32	.55	.0425
			Dry		.35	79.30	20.35	.55	

DENVER No. 12.

Coking tests.

	Test 229.	Test 231.	Test 232.
Date	2,24,08	2,26,08	2,28,08
Duration ....hours..	49	27	46
Size:			
As shipped	r. o. m.	r. o. m.	r. o. m.
As used	r., f. c.	r., n. c.	w., f. c.
Coal charged:			
Wet ....pounds..	9,360	7,820	10,500
Dry ....do....	8,881	7,402	9,594
Coke produced	None	None	None

Remarks.—Test No. 229: No coke produced. All volatile expelled. Charge did not swell at all, and only developed a few small cracks down a few inches.

Test No. 231: No coke produced. All volatile apparently expelled. Drawn from oven in same form as coal charged, upper layers covered with deposited carbon, showing intense heat. Oven was closed tight for three hours after charging in endeavor to crack and soak charge. Cracks very few and only extended down about 3 inches.

Test No. 232: No coke produced. The coal for this charge was passed through jig in order to thoroughly wet. It was hoped this wetting, together with closing oven, as in test 231, would develop cracks, but result was same as two preceding tests. All volatile was expelled, but resultant product did not stick together and was drawn in same form as charged.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
229	347-D	Coal, Wet	5.12	38.46	45.94	10.48	0.55
		Coal, Dry	....	40.54	48.42	11.04	.58
231	349-D	Coal, Wet	5.35	40.10	46.56	7.99	.48
		Coal, Dry	....	42.37	49.19	8.44	.50
232	359-D	Coal, Wet	8.63	38.44	46.17	6.76	.51
		Coal, Dry	....	42.07	50.53	7.40	.56

DENVER No. 13.

Coking tests.

	Test 233.
Date	2,27,08
Duration ....hours..	22
Size:	
As shipped	r. o. m.
As used	r., f. c.
Coal charged:	
Wet ....pounds..	9,710
Dry ....do....	7,652
Coke produced	None

Remarks.—Test No. 233: No coke produced. This coal subbituminous.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
233	358-D	Coal, Wet	21.19	36.91	37.12	4.78	0.34
		Coal, Dry	....	46.83	47.11	6.06	.43

DENVER No. 14.

Coking tests.

	Test 242.	Test 243.	Test 244.	Test 245.	Test 246.
Date	3,16,08	3,17,08	3,18,08	3,21,08	3,21,08
Duration ... hours	65	72	45	56	48
Size:					
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	r., f. c.	r., f. c.	r., n. c.	r., f. c.	r., f. c.
Coal charged:					
Wet ... pounds	12,160	13,300	8,490	11,000	9,280
Dry ... do	11,771	12,998	8,195	10,678	8,321
Coke produced:					
Wet ... do	6,000	5,100	5,086	5,700	4,350
Wet ... per cent	49.34	38.34	59.91	51.82	46.88
Dry ... pounds	5,987	5,037	5,044	5,681	4,330
Dry ... per cent	50.86	38.75	61.55	53.20	52.04
Breeze produced:					
Wet ... pounds	2,061	3,141	936	1,212	1,770
Wet ... per cent	16.95	23.62	11.02	11.02	19.07
Dry ... pounds	2,056	3,102	928	1,208	1,762
Dry ... per cent	17.46	23.87	11.32	11.31	21.17
Total yield:					
Wet ... do	66.29	61.96	70.93	62.84	65.95
Dry ... do	68.32	62.62	72.87	64.51	73.21
Physical properties of coke:					
Specific gravity—					
Apparent	.91	1.01	.82	.96	.96
Real	1.87	1.83	1.76	1.76	1.76
Volume—					
Coke ... per cent	49.00	55.00	47.00	55.00	55.00
Cells ... do	51.00	45.00	53.00	45.00	45.00
Weight per cubic foot—					
Wet ... pounds	88.47	87.78	92.54	87.78	87.55
Dry ... do	56.65	62.22	50.71	59.70	59.47
6-foot drop test over 2-inch mesh—					
1 ... per cent	87.50	86.00	92.00	90.00	89.50
2 ... do	80.00	79.50	82.50	79.50	77.50
3 ... do	73.00	68.00	77.00	72.50	67.50
4 ... do	65.00	65.50	72.00	66.50	60.00
5 ... do	65.00	69.00	80.00	68.50	57.50

Remarks.—Test No. 242: Fine-fingered coke. Light gray color. Cell structure small, dense. Breakage, very badly cross fractured. Upper 4 inches fused mass of separate coal particles, no cells; middle 10 inches hard dense coke, fingered; bottom 6 inches separate coal particles not fused together, but with volatile expelled.

Test No. 243: Same as No. 242. Larger per cent breeze, due to larger size of charge and inability to burn to bottom, some unburnt coal being drawn.

Test No. 244: Light gray and silvery color, large deposit carbon. Drawn from oven in lumps same size as charged, from fines to 12-inch cubes. All volatile expelled. Very fine cells. Metallic ring. Lumps on fracture have appearance of charcoal structure. Very light weight. Charge did not fuse or show any evidence of running together, but every coal particle coked separately.

Test No. 245: Dull gray color. Poor, soft coke. Fine fingered and badly cross fractured. Metallic ring. Cell structure very small, dense.

Test No. 246: This charge thoroughly wet before charging in attempt to hold back oven and get larger and more open cracks; no results. Produced poor, soft, fine-fingered coke. Dull gray color, some little deposit of carbon on upper 2 inches. Cell structure small, dense. Breakage, badly cross fractured. Metallic ring. Very light weight.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
242	400-D	Coal	Wet	3.20	38.36	53.78	4.66	0.55	
			Dry		39.63	55.56	4.81	.57	
	402-D	Coke	Wet	.22	.94	90.53	8.31	.56	0.0180
			Dry		.94	90.73	8.33	.56	
243	401-D	Coal	Wet	2.27	40.17	52.68	4.88	.60	
			Dry		41.10	53.91	4.99	.61	
	421-D	Coke	Wet	1.23	1.82	89.13	7.82	.65	.0248
			Dry		1.84	90.24	7.92	.66	
244	403-D	Coal	Wet	3.48	40.95	51.08	4.49	.63	
			Dry		42.43	52.92	4.65	.65	
	420-D	Coke	Wet	.83	.92	90.46	7.79	.51	.0275
			Dry		.93	91.22	7.85	.51	
245	423-D	Coal	Wet	2.93	40.15	52.19	4.73	.64	
			Dry		41.36	53.78	4.86	.66	
	436-D	Coke	Wet	.34	.81	90.37	8.48	.69	.0300
			Dry		.81	90.68	8.51	.69	
246	422-D	Coal	Wet	10.33	36.52	48.25	4.90	.53	
			Dry		40.74	53.80	5.46	.59	
	437-D	Coke	Wet	.47	.90	89.06	9.57	.73	.0260
			Dry		.90	89.48	9.62	.73	

DENVER, Nos. 6 AND 7, MIXED.

Coking tests.

	Test 220.	Test 224.
Date	2,9,08	2,14,08
Duration ... hours	25	22
Size:		
As shipped	3-in. nut & r. o. m.	3-in. nut & r. o. m.
As used	w., f. c.	w., f. c.
Coal charged:		
Wet ... pounds	8,250	6,210
Dry ... do	7,814	5,809
Coke produced:		
Wet ... do	5,222	3,365
Dry ... do	5,216	3,318
Wet ... per cent	63.30	54.19
Dry ... do	66.75	57.12
Breeze produced:		
Wet ... pounds	177	513
Dry ... do	177	506
Wet ... per cent	2.14	8.26
Dry ... do	2.27	8.71
Total yield:		
Wet ... do	65.44	62.45
Dry ... do	69.02	65.83

	Test 220.	Test 224.
Physical properties of coke:		
Specific gravity—		
Apparent	1.11	1.00
Real	1.93	1.86
Volume—		
Coke ... per cent	58.00	54.00
Cells ... do	42.00	46.00
Weight per cubic foot—		
Wet ... pounds	95.36	90.18
Dry ... do	69.15	61.49
6-foot drop test over 2-inch mesh—		
1 ... per cent	97.50	96.50
2 ... do	93.00	94.00
3 ... do	90.50	88.50
4 ... do	89.00	84.00
5 ... do	90.50	84.50

Remarks.—Test 220: Proportions 1 to 3. Coke light gray color. Cell-structure good. Breakage cross-fractured and irregular, but pieces of good size; 6-inch cubes. Mixture of noncoking No. 6 appears to have opened cells.

Test 224: Proportions 2 to 1. Coke dull gray color; soft, dense, punky. Cell-structure exceedingly small, only visible by means of magnifying glass. Breakage very poor and irregular, cohesion slight. Percentage of breeze very large. This was an attempt to show possibility of producing coke from noncoking coal by addition of good coking coal. Results seem to indicate that noncoking coal acts simply as dilutent and on this particular coal at least 50 per cent of good coal is required to make passable coke.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
220	299-D	Coal Wet	5.28	32.45	50.64	11.63	0.58	
		Coal Dry		34.26	53.46	12.28	.61	
	307-D	Coke Wet	.12	.12	81.90	17.86	.59	0.0086
		Coke Dry		.12	82.00	17.88	.59	
224	328-D	Coal Wet	6.46	34.25	48.03	11.26	.67	
		Coal Dry		36.61	51.35	12.04	.72	
	329-D	Coke Wet	1.40	1.16	78.77	18.67	.58	.0109
		Coke Dry		1.18	79.89	18.93	.59	

DENVER Nos. 9 AND 12, MIXED.

Coking tests.

	Test 237.
Date	3,5,08
Duration ... hours	45
Size:	
As shipped	r. o. m.
As used	f.c., No. 9 w., No. 12 r.
Coal charged:	
Wet ... pounds	10,000
Dry ... do	9,407
Coke produced	None

Remarks.—Test No. 237: Proportions, 1 to 4. No coke produced. Some few pieces of slightly adhering product, with volatile driven out, which fall to pieces when drawn.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
237	370-D	Coal Wet	5.93	38.30	44.40	11.37	0.46
		Coal Dry		40.71	47.20	12.09	.49

DENVER Nos. 12 AND 13, MIXED.

Coking tests.

	Test 234.
Date	2,29,08
Duration ... hours	12
Size:	
As shipped	r. o. m.
As used	r., f. c.
Coal charged:	
Wet ... pounds	8,710
Dry ... do	7,719
Coke produced	None

Remarks.—Test No. 234: Proportions, 1 to 1. No coke produced. Burned for about twelve hours and blaze lost. Ashed down about 2 inches. This was attempt to produce coke from two noncoking coals, one, Denver 12, very dry, and other, Denver 13, very high in moisture.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
234	360-D	Coal Wet	11.38	38.55	43.05	7.02	0.44
		Coal Dry		43.50	48.58	7.92	.50

DENVER Nos. 8 AND 12, MIXED.

Coking tests.

	Test 238.	Test 239.		Test 238.	Test 239.
Date	3,6,08	3,7,08	Physical properties of coke:		
Duration ... hours	38	30	Specific gravity—		
Size:			Apparent	1.00	1.02
As shipped	r. o. m.	r. o. m.	Real	1.85	1.80
As used	f.c.,No.8	w.,No.12 r.	Volume—		
Coal charged:			Coke ... per cent	54.00	57.00
Wet ... pounds	10,000	8,000	Cells ... do	46.00	43.00
Dry ... do	9,543	7,642	Weight per cubic foot—		
Coke produced:			Wet ... pounds	83.32	90.37
Wet ... do	5,850	4,599	Dry ... do	62.26	63.55
Wet ... per cent	58.50	57.49	6-foot drop test over 2-inch mesh—		
Dry ... pounds	5,841	4,593			
Dry ... per cent	61.21	60.10	1 ... per cent	96.00	97.00
Breeze produced:			2 ... do	93.50	94.00
Wet ... pounds	421	257	3 ... do	90.00	90.00
Wet ... per cent	4.21	3.21	4 ... do	88.50	86.50
Dry ... pounds	420	257	5 ... do	88.00	89.50
Dry ... per cent	4.40	3.36			
Total yield:					
Wet ... do	62.71	60.70			
Dry ... do	65.61	63.46			

Remarks.—Test No. 238: Proportions, 2 to 3. Poor, dense coke. Very hard. Dull gray color, some little deposit of carbon on upper 4 inches. Cell structure very small. Breakage, badly cross fractured.

Test No. 239: Proportions, 1 to 1. Coke same as in test No. 238; larger proportion of good coking coal improves but slightly, if at all.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
238	371-D	Coal, Wet	4.57	35.64	50.02	9.77	0.64	
		Coal, Dry		37.35	52.41	10.24	.67	
	375-D	Coke, Wet	.16	1.12	83.20	15.52	.71	0.0184
		Coke, Dry		1.12	83.34	15.54	.71	
239	374-D	Coal, Wet	4.47	35.86	49.70	9.97	.59	
		Coal, Dry		37.54	52.02	10.44	.62	
	376-D	Coke, Wet	.13	.50	82.41	16.96	.64	.0200
		Coke, Dry		.50	82.52	16.98	.64	

DENVER Nos. 8 AND 13, MIXED.

Coking tests.

	Test 235.		Test 235.
Date	3,3,08	Total yield:	
Duration of test ... hours	47	Wet ... per cent	48.31
Size:		Dry ... do	49 33
As shipped	r. o. m.	Physical properties of coke:	
As used	f. c., No. 8 w., No. 13 r.	Specific gravity—	
		Apparent	1.03
		Real	1.88
Coal charged:		Volume:	
Wet ... pounds	10,100	Coke ... per cent	55.00
Dry ... do	9,795	Cells ... do	45.00
Coke produced:		Weight per cubic foot—	
Wet ... do	3,600	Wet ... pounds	91.67
Wet ... per cent	35.64	Dry ... do	63.59
Dry ... pounds	3,565	Six-foot drop test over 2-inch mesh—	
Dry ... per cent	36.40		
Breeze produced:		1 ... per cent	91.00
Wet ... pounds	1,280	2 ... do	84.50
Wet ... per cent	12.67	3 ... do	76.00
Dry ... pounds	1,267	4 ... do	70.00
Dry ... per cent	12.93	5 ... do	71.50

Remarks.—Test No. 235: Proportions 2 to 3. Produced 35.64 per cent soft, punky coke. Very dense; cohesion slight. Breeze very high. Test demonstrates uselessness of attempting to coke this subbituminous coal by addition of coking coal.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
235	364-D	Coal, Wet	13.02	34.48	45.80	6.70	0.39	
		Coal, Dry		39.64	52.66	7.70	.45	
	373-D	Coke, Wet	.98	3.29	82.80	12.93	.58	0.0086
		Coke, Dry		3.32	83.61	13.07	.59	

DENVER Nos. 1, 2, AND 3, MIXED.

Coking tests.

	Test 206.		Test 206.
Date	1,6,08	Total yield:	
Duration, hours	49	Wet, per cent	64.22
Size:		Dry, do	66.36
As shipped	r. o. m.	Physical properties:	
As used	w., f. c.	Specific gravity—	
Coal charged:		Apparent	1.03
Wet, pounds	12,570	Real	1.95
Dry, do	12,150	Volume—	
Coke produced:		Coke, per cent	53.00
Wet, do	7,783	Cells, do	47.00
Dry, do	7,774	Weight per cubic foot—	
Wet, per cent	61.92	Wet, pounds	93.46
Dry, do	63.98	Dry, do	64.16
Breeze produced:		6-foot drop test over 2-inch mesh—	
Wet, pounds	290	1, per cent	98.00
Dry, do	289	2, do	95.50
Wet, per cent	2.30	3, do	93.00
Dry, do	2.38	4, do	89.50
		5, do	91.00

Remarks.—Proportions, No. 1, 31.26 per cent; No. 2, 54.34 per cent; No. 3, 14.40 per cent. Coke dark gray color with a little silvery deposited carbon. Cell structure good, dense on outside. Breakage good, regular sized pieces. Metallic ring. Good, strong coke. Mixture makes good product, probably better than that from any separate charge.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
206	210-D	Coal, Wet	3.34	32.17	51.82	12.67	0.72	
		Coal, Dry		33.28	53.61	13.11	.75	
	224-D	Coke, Wet	.12	.49	78.74	20.65	.50	0.0215
		Coke, Dry		.49	78.83	20.68	.50	

CONCLUSIONS.

Coal No. 6, with the addition of 66⅔ per cent of good coking coal (test 220), produced good coke, but when the percentage was lowered to 25 (test 224) the resultant product was poor, soft, and dense. This apparently shows that noncoking coal acted simply as a diluent. Coal No. 12, with the addition of 40 per cent of good coking coal (test 238) produced only poor coke; with the addition of 50 per cent (test 239) it showed little, if any, improvement, and with the addition of only 25 per cent (test 237) no coke was produced. Coal No. 13, with the addition of 40 per cent of good coking coal (test 235), produced poor, soft coke that barely stuck together; this test demonstrates the uselessness of attempting to coke subbituminous coals by the addition of coking coal.

The mixing of coal of high moisture content with very dry coal (test 234), both noncoking, in an attempt to produce coke, gave no evidence of coking.

As a supplement to the results of the 6-foot drop test, it was deemed advisable to compare the percentage obtained from four drops as heretofore, and that from four drops without intermediate screening. In the majority of tests, as was to be expected, the small coke, taken out in the regular test, helped to reduce the breakage. When the difficulties of sampling, etc., are considered, the third drop of the regular test and the fourth of consecutive drops compare favorably. The separate drops are shown to give an idea of the amount of breakage that might be expected, according to the number of times handled, this number varying, of course, in different lines of commercial work.

The loss of sulphur in the 44 tests that produced coke averages 35.05 per cent, the lowest being 9.42 per cent for Denver No. 14 (test 246), and the highest 58.75 per cent for Denver No. 9 (test 241).

SURVEY PUBLICATIONS ON FUEL TESTING.

The following publications, except those to which a price is affixed, can be obtained free by applying to the Director, Geological Survey, Washington, D. C. The priced publications can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

BULLETIN 261. Preliminary report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, in St. Louis, Mo., 1904; E. W. Parker, J. A. Holmes, M. R. Campbell, committee in charge. 1905. 172 pp. 10 cents.

PROFESSIONAL PAPER 48. Report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904; E. W. Parker, J. A Holmes, M. R. Campbell, committee in charge. 1906. In three parts. 1492 pp., 13 pls. $1.50.

BULLETIN 290. Preliminary report on the operations of the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., 1905, by J. A. Holmes. 1906. 240 pp. 20 cents.

BULLETIN 323. Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, Mo., January 1, 1905, to July 31, 1906, by N. W. Lord. 1907. 49 pp.

BULLETIN 325. A study of four hundred steaming tests, made at the fuel-testing plant, St. Louis, Mo., 1904, 1905, and 1906, by L. P. Breckenridge. 1907. 196 pp.

BULLETIN 332. Report of the United States fuel-testing plant at St. Louis, Mo., January 1, 1906, to June 30, 1907; J. A. Holmes, in charge. 1908. 299 pp.

BULLETIN 334. The burning of coal without smoke in boiler plants: a preliminary report, by D. T. Randall. 1908. 26 pp.

BULLETIN 336. Washing and coking tests of coal and cupola tests of coke, by Richard Moldenke, A. W. Belden, and G. R. Delamater. 1908. 76 pp.

BULLETIN 339. The purchase of coal under Government and commercial specifications on the basis of its heating value, with analyses of coal delivered under Government contracts, by D. T. Randall. 1908. 27 pp.

BULLETIN 343. Binders for coal briquets, by J. E. Mills. 1908. 56 pp.

BULLETIN 362. Mine sampling and chemical analyses of coals tested at the United States fuel-testing plant, Norfolk, Va., in 1907, by J. S. Burrows. 1908. 23 pp.

BULLETIN 363. Comparative tests of run-of-mine and briquetted coal on locomotives, by W. F. M. Goss. 1908. 57 pp.

BULLETIN 366. Tests of coal and briquets as fuel in house-heating boilers, by D. T. Randall. 1908. 44 pp.

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