Bulletin No. 332

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

REPORT

OF THE

UNITED STATES FUEL-TESTING PLANT, AT ST. LOUIS, MO.

JANUARY 1, 1906, TO JUNE 30, 1907

JOSEPH A. HOLMES
IN CHARGE

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REPORT OF THE UNITED STATES FUEL-TESTING PLANT AT ST. LOUIS, MO., JANUARY 1, 1906–JUNE 30, 1907.

JOSEPH A. HOLMES, *in charge.*

INTRODUCTION.

By JOSEPH A. HOLMES.

WORK DONE.

The authority for continuing at St. Louis, Mo., the investigation of the fuel values and possibilities of the coals and lignites of the United States, is contained in the act of Congress making appropriation for the sundry civil expenses of the Government for the fiscal year ending June 30, 1907. This act provides—

> For the continuation of the analyzing and testing of the coals, lignites, and other mineral fuel substances belonging to the United States, in order to determine their fuel value and so forth, under the supervision of the Director of the United States Geological Survey, to be immediately available, two hundred and fifty thousand dollars: *Provided*, That in examinations, hereby authorized, of fuel materials for the use of the Government of the United States, or for the purpose of increasing the general efficiency or available supply of the fuel resources in the United States, the Director of the Geological Survey may have the necessary materials collected from any part of the United States where they represent extensive deposits; and it shall be the duty of the Director of the Geological Survey to have examined, without charge, the fuels required for use by the Government of the United States, and to give these examinations preference over other work: *Provided further*, That in publishing the results of these investigations the materials examined shall not be credited to any private party or corporation, but shall be collected and described as representing such extensive deposits.

The provisos in the above act limiting the examinations and the manner of publishing the results of tests, by prohibiting the mention of private parties or corporations furnishing materials, necessarily changed somewhat the general operations of the fuel-testing plant, especially in so far as such operations were related to field collections of samples for testing.

This appropriation became available on July 1, 1906. The present report includes operations for some months prior to the enactment

of the above-quoted legislation, but in view of the fact that the publication of the results is provided for in this act it has been ruled by the Department of the Interior that no mention shall be made of names of private parties or corporations furnishing materials, even though such materials were furnished and tested prior to the enactment of these provisos. The appropriation above recited covers the period from July 1, 1906, to June 30, 1907, but this report covers the period from January 1, 1906, to June 30, 1907, inclusive, or until the date of removal of the fuel-testing plant from St. Louis to Norfolk, Va., and to Denver, Colo. In point of fact little testing was carried on subsequent to March 31, 1907, because of the dismantling of the St. Louis plant.

During this period the scope of the work has been largely confined to a series of comparative tests, made as nearly as possible under uniform conditions, on samples of bituminous coal and lignite collected from different fields of the United States. The samples accepted, however, in accordance with the limitations already indicated, have been so chosen as to be representative so far as possible of known extensive deposits, and thus have typified a fewer number of fields. Moreover, the tests have been made more conclusive by using in them larger quantities of coal of the same sample or type, the tests when occasion demanded being extended over longer periods of time.

The plant in which the investigations were carried on has remained at its original location in Forest Park, St. Louis, Mo. The installation of the plant has remained practically as reported in Bulletin No. 290, and included a chemical laboratory, a boiler and engine house; a storage and washery building, two buildings for briquetting purposes, a drying plant, and three full-size beehive coke ovens, all except the chemical laboratory being the property of the United States Government.

The equipment of the plant during the period covered by this report has remained much as it was during 1904, and as described in detail in Bulletin No. 290 and Professional Paper No. 48.

In March, 1907, all active testing of fuels at St. Louis was discontinued and the fuel-testing plant dismantled. The sections of steam, producer-gas, and briquetting were transferred to a new plant erected at Norfolk, Va., and the sections of coking and washery were transferred to a new plant erected at Denver, Colo. The remainder of the fiscal year was occupied in this transfer, so that practically no investigations connected with active fuel testing other than field and laboratory work were in progress from March to the close of the fiscal year, June 30, 1907.

Most of the experts who conducted the investigations during 1905 have remained in charge of the tests to the close of the period here covered. No general committee has been appointed by the Director

of the Geological Survey to oversee the operation of the plant, as in 1904 and 1905, the entire direction of the plant being given over to the expert in charge, reporting immediately to the Director.

The division of fuels was consolidated with the division of structural materials and with some miscellaneous investigations into a new branch of the Geological Survey, the technologic branch, by order of the Secretary of the Interior, April 2, 1907. The administrative office was established in Washington, and to it was removed the official headquarters of both divisions above named, which had heretofore been at St. Louis. The permanent organization in Washington thereafter embraced the expert in charge, Joseph A. Holmes; the chief engineer, H. M. Wilson, who in the absence of the expert in charge assumes his duties, and necessary editorial assistants and general clerical force engaged in correspondence, records, supplies, shipments, accounts, etc.

From the Washington office directions are issued in respect to the investigations, tests, and field work conducted at branch testing stations and laboratories.

The names of the experts and assistants employed in connection with the several divisions of the testing work are given in the introductions to the accompanying reports covering these tests. Those in charge or having special appointments have remained practically as reported in Bulletin No. 290, with the exception of John D. Wick, who was succeeded in charge of washing tests by G. R. Delamater, and John A. Laird, who was succeeded in charge of operating gas producers by J. P. Quam, who remained also in charge of the gas engine.

The tests reported herein were made on samples of fuel from the following States and Territories, the number of samples from each being also shown:

Alabama	5	Ohio	3
Argentina	1	Pennsylvania	12
Arkansas	7	Rhode Island	1
Florida	1	Tennessee	15
Georgia	1	Texas	2
Illinois	28	Utah	2
Indiana	13	Virginia	3
Indian Territory	4	Washington	3
Kansas	2	West Virginia	8
Kentucky	4	Wyoming	3
Maryland	1	Miscellaneous	7
Missouri	5		139
Montana	2		
New Mexico	6		

Each fuel tested went through one or more of the following operations: Samples of the fuel were taken by inspectors sent to the various mines by the Survey for this purpose, and were forwarded for

chemical analyses. Samples were also taken from the cars, from the fuel as fired to the boilers, as fed to the producers, before briquetting, before and after washing, and before coking. All these samples were forwarded to the chemical laboratory, where proximate analyses, and for many samples ultimate analyses, were made. Samples of briquetted coal and of coke, as well as the gases produced from the fuels, were also analyzed. All these analyses are reported herein and were made by the methods described in Bulletin No. 323, entitled "Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, Mo."

Steaming tests were made to determine the calorific value of the fuel and the relative amount of energy obtainable from it when used under a boiler in connection with a steam engine, as compared to the energy obtainable from the fuel when used in a gas producer and gas engine; also to determine methods of burning fuel smokelessly and in such a manner as to secure the highest efficiency in the combustion chamber. These tests are summarized in greater detail in Bulletin No. 325, entitled "A study of four hundred steaming tests." Producer-gas tests were made to determine the absolute efficiency of each fuel, as well as the relative efficiency when used under steam boilers, as stated above.

Washing tests were made to determine the possibility of improving the quality of the coal and the availability of such washed coals for the production of coke, since the coal used in coke must be as free as possible from ash, sulphur, and other impurities, because of its prospective use in metallurgic processes. Coking tests were made to determine the possibility of utilizing the various coals in this way or of improving coking practice. Cupola tests of cokes were made to determine the possibility of using these different cokes in actual foundry practice and of thereby possibly improving foundry practice. Briquetting tests were made to determine the extent to which slack and waste coal can be economically made into briquets, and steaming tests on briquets were made to determine the relative and absolute efficiency obtained when burned under the steam boiler, as compared with that obtained with other forms of fuel.

The results of these investigations, wherein each fuel has been tested comparatively in a number of ways, are shown in the accompanying report. The producer-gas investigations have continued to show the availability of bituminous coals, lignites, and peat rich in volatile matter, for the production of power. Improvements in the method of handling of the gas-producer equipment of the plant have yielded gratifying results, confirming and augmenting those of the preceding year, and have demonstrated the efficiency of the commercial producer in developing a good grade of producer gas through proper manipulation of scrubbing and purifying appliances and tar extractors. These investigations have also indicated the

lines along which improvements in gas-producer construction might reasonably be expected, in order that the producer may utilize advantageously all varieties of bituminous coal, and especially low-grade fuels now being wasted.

The briquetting plant has developed new possibilities in the utilization of slack coal and of anthracite culm, when properly briquetted, as an efficient fuel for combustion on locomotives, both in the express service, where a smokeless fuel is required on entering large cities, and in heavy freight service, where high efficiency in hauling over steep grades is required for a limited period. The experiments made in burning briquetted coal on the Pennsylvania Railroad and the Missouri Pacific Railway are being continued on other lines, and have developed results highly gratifying to the transportation interests of the country. These experiments are being extended with a view to determining the value of briquetted coal for combustion on the naval vessels of the United States, the twofold object being to secure a smokeless fuel and a fuel of higher efficiency, especially for use on torpedo boats and other naval vessels. The annexed report on the operations of the briquetting section is segregated into two parts. Under "Briquetting tests" are reported those operations which had to do with the mechanical, physical, and chemical manufacture and testing of briquets. The combustion tests under steam boilers were conducted, as a matter of expediency, under the direction of the chief of the briquetting section, but are reported under "Steaming tests," though the steam-boiler section is in no way responsible for the results of these tests. It is contemplated that in the future such combustion tests of briquets, including the locomotive tests, shall be made under the direction of the steam-boiler section.

THE OUTLOOK FOR FUTURE WORK.

The fuel problems needing investigation in the immediate future include practically all those outlined in Bulletin No. 290 (p. 10), but it will be possible to undertake only a small portion of these during the forthcoming year. The more important of these problems are (1) the lessening of the waste in mining and (2) greater efficiency in the utilization of the coal that is mined. From the data now in hand it is estimated that this waste in mining now exceeds 400,000,000 tons of coal yearly.

The washing and coking appliances which have been removed from St. Louis to Denver will be occupied throughout the year on tests to determine coking values and the methods of coking the coals found on or adjacent to the public lands of the West—chiefly coals that belong to the United States or are indicative of the possible behavior of such coals. Washing tests will be made with a view to determining how these fuels may be improved for coking or for combustion.

The principal chemical laboratory of the fuel-testing plant has been removed to Pittsburg, and to it will be sent all fuel samples for analysis, including briquets, coke, etc. At this laboratory will be conducted an exhaustive series of investigations into the most efficient methods of using, for coke and other purposes, the coals and lignites belonging to the Government of the United States, and the by-products of coke, with a view to determining methods for their utilization. A branch chemical and physical laboratory will be maintained at the Norfolk fuel-testing plant for the purpose of experimenting on the gases in different portions of the combustion chambers of steam boilers and of gas producers, analyses to be made of the gases at high temperatures, and the highest temperatures to be measured. It is expected that the results of these investigations may have an important bearing on the methods of construction of combustion chambers and the relation of the heat-transmitting surfaces to the fuel bed. Routine chemical work will be conducted as heretofore at the fuel-testing plants for analyses of samples, including gas and other products of combustion. A special investigation will be undertaken to ascertain the nature of cokes made from different coals, with a view to determining why good coke can be made from one coal and not from another. Field investigations will be made with a view to studying the coals where found, and later these investigations will be continued in the laboratories at Washington.

The smoke-abatement investigations at public buildings will be supplemented by more detailed experiments along the same lines at the Norfolk plant, where different methods of handling the two Heine boilers and the new 250-horsepower Babcock & Wilcox water-tube boiler will be attempted. One of these boilers will be hand fired, one fired with mechanical overfeed, and one with a mechanical underfeed stoker. All three are equipped for natural draft, for forced draft, and for induced draft, and it is believed that it will be possible to show just how each type of fuel should be burned in order to secure the highest efficiency, which means the complete combustion of all of the carbon and the abatement of smoke. This investigation is conducted with special reference to the needs of power and heating plants in the Government buildings in the different cities of the country.

The gas producer will be run on prolonged tests with a view to determining along commercial lines the fuel values through the gas engine of the various fuels tested; also with a view to determining the possibility of utilizing the different classes of fuel through the gas producer for naval purposes.

The investigation of coal waste at the mines is being extended with a view to determining how far such waste is due to improper methods of mining, especially to the improper use of explosives or to the use of improper explosives. Investigations are also being made to discover

the extent to which less wasteful methods of mining may be introduced without excessive cost to the operators. (See p. 9.)

Under the wording of the act of Congress providing for the continuation of the work to June 30, 1908, the technologic branch is engaged in revising the purchases of coals for the Government, with a view to adopting better methods of making such purchases, especially in regard to specifications which shall consider the ash contained and the heating units in the coal. This branch is also engaged in investigating and reporting on explosives and other materials used by the Reclamation Service and in the Panama Canal. To it has recently been transferred the mine inspection in the Territories, and this part of the work of Federal mine inspection will receive particular attention during the coming year.

ABBREVIATIONS.

The following abbreviations are used in the report:

B. t. u. =British thermal units.
cr. =crushed.
c. t. p. =coal-tar pitch.
e. h. p. =electrical horsepower.
Eng. =English (briquetting machine).
f. c. =finely crushed.
Lab. No. =chemical laboratory number.
l. =lump.
Renf. =Renfrow (briquetting machine).
r. o. m. =run of mine.
r. p. m. =revolutions per minute.
s. =slack.
sc. =screenings.
w. =washed.
w. g. p. =water-gas pitch.
* =briquets used in locomotive test (see p. 42).
† =briquets used in house-boiler test (see p. 42).

FIELD WORK.

By EDWARD W. PARKER and J. SHOBER BURROWS

INTRODUCTION.

The conditions for submitting coal to be tested and the methods of inspecting the mine and obtaining mine supplies were the same for the period covered by this report as during the year 1905.[a]

PERSONNEL.

John W. Groves and William J. Von Borries inspected and shipped most of the samples until March, 1906, when Mr. Von Borries resigned. From March until July all the samples were shipped by Messrs. Burrows and Groves, with the exception of three from the State of Washington, which were secured by M. R. Campbell, of the geologic branch. At the beginning of the fiscal year, July 1, 1906, Mr. Parker was relieved of his duties in connection with this work and Mr. Burrows, who had directed the field work under Mr. Parker's supervision, was placed in full charge of the corps of inspectors. During the summer and autumn F. B. Tough and A. K. Adams were employed for a few months, and K. M. Way and R. T. Carroll joined the corps of inspectors during this period. N. H. Darton, of the geologic branch, cooperated with the technologic branch in procuring samples from Montana.

DESIGNATION OF SAMPLES.

When the sample or car of coal is shipped it is marked with the name of the State in which the mine is situated and numbered consecutively in the order of shipment, the numbers for 1906 beginning where those for 1905 left off. When two or three cars or lots constituting different grades of coal, such as lump, nut, etc., are shipped from a mine, each lot is designated by a letter. For example, Illinois No. 23 A, the first shipment, is lump coal, and Illinois No. 23 B is slack coal taken from the same mine.

[a] See Bull. U. S. Geol. Survey No. 290, 1906, p. 16.

SAMPLES RECEIVED AND TESTED.

During the period covered by this report 137 samples from 24 States and Territories and 1 sample from Argentina were received and tested.

The following is a complete list of the carload samples received, with the details of the location of the bed, character of the samples, inspector, and page references for all the tests made on these fuels during the period here included:

Samples of fuels received and tests made, by States.

Field number of sample.	Kind of fuel.	Name of bed.	Locality.	County.	Railroad.	Inspector.	Page of this report on which are discussed the—							
							Field work.	Chemical analyses.	Steaming tests.	Producer-gas tests.	Washing tests.	Coking tests.	Cupola tests.	Briquetting tests.
Alabama:														
No. 2 B	Bituminous; run of mine	Jagger	Carbon Hill	Walker	Frisco	J. S. Burrows	47	47	48	....	48	48	49	49
No. 3	do	Underwood or Thompson.	Garnsey	Bibb	Louisville and Nashville.	J. W. Groves	50	50	51	....	51	51	52	....
No. 4	do	Youngblood	Belle Ellen	do	do	do	52	53	53	54	54	54	55	56
No. 5	do	Black Creek	Lehigh	Blount	do	do	56	57	57	....	57	58	....	....
No. 6	do	Pratt	Dolomite	Jefferson	do	K. M. Way	58	58	59	59	60	60	....	....
Argentina No. 1				Province of Mendoza.		Uninspected	61	61	62	....	62	....	....	63
Arkansas:														
No. 1 B	Bituminous; slack	Huntington	Huntington	Sebastian	Frisco	J. W. Groves	63	64	....	....	64	64	65	....
No. 7 A	Bituminous; lump, over 2-inch perforated screen.	Hartshorne	Midland (4 miles southwest).	do	Midland Valley	do	65	66	66	67	....	....	....	....
No. 7 B	Bituminous; slack, through 2-inch perforated screen.	do	do	do	do	do	65	66	....	....	67	67	68	69
No. 8	Semianthracite; size 4, through 1¼-inch round perforated screen.	(?)	Spadra	Johnson	St. Louis, Iron Mountain and Southern.	W. J. Von Borries	69	69	70	70	71	....	....	....
No. 9	Bituminous; slack, through 1⅛-inch bar screen.	Huntington	Bonanza	Sebastian	Frisco	J. W. Groves	71	71	....	....	71	71	72	....
No. 10	Lignite; run of mine	(?)	Lester (7 miles west).	Ouachita	St. Louis, Iron Mountain and Southern.	do	73	73	73	74	....	....	....	....
No. 13	Bituminous; slack	(?)	Denning	Franklin	do	Uninspected	74	75	....	....	....	....	....	75
Florida No. 1	Machined peat	....	Orlando	Orange	Seaboard	J. S. Burrows	76	77	77	77	....	....	....	....
Georgia No. 1	Bituminous; lump, over 1¼-inch perforated stationary screen.	Little River	Menlo	Chattooga	Chattanooga Southern.	A. K. Adams	78	78	79	....	....	79	....	....
Illinois:														
No. 7 E	Bituminous; screened nut	No. 6	Collinsville	Madison	Vandalia	Uninspected	79	80	80	....	....	....	....	80
No. 9 C	Bituminous; slack	do	Staunton	Macoupin	Litchfield and Madison.	do	81	81	81	....	....	....	....	82

No. 12 B	Bituminous; size 5	do	Bush	Williamson	St. Louis, Iron Mountain and Southern.	do	83	83	83						84
No. 19 C	Bituminous; run of mine	No. 7	Ziegler	Franklin	Illinois Central	J. W. Groves	85	85	85	86					
No. 19 D	Bituminous; lump, over 6-inch shaking screen.	do	do	do	do	do	85	85	85						
No. 19 E	Bituminous; through 1½-inch shaking screen.	do	do	do	do	do	85	85	85						
No. 20	Bituminous; screenings	No. 6	Staunton	Macoupin	Litchfield and Madison.	Uninspected	87	87	87		88	88		88	
No. 21	Bituminous; lump, over 2¼-inch screen.	do	Troy	Madison	St. Louis, Troy and Eastern.	J. W. Groves	89	89	89	90	91	91		91	
No. 22 A	Bituminous; lump, over 4-inch perforated shaking screen.	do	Marysville	do	do	do	91	92	92	93	93				
No. 22 B	Bituminous; nut, pea, and slack, through 2-inch perforated screen.	do	do	do	do	do	91	92			93	93	94		
No. 23 A	Bituminous; lump, over 5-inch perforated screen.	do	Donkville	do	do	do	94	95	95	96	96	97			
No. 23 B	Bituminous; slack, through 2-inch perforated screen.	do	do	do	do	do	94	95	95	96	96	97		97	
No. 24 A	Bituminous; screenings, through 2½-inch shaking screen.	do	New Baden	Clinton	Southern	W. J. Von Borries	97	98			99	99			
No. 24 B	Bituminous; lump, over 5½-inch bar screen.	do	do	do	do	do	97	98	98	99	99	99			
No. 25 A	Bituminous; run of mine	do	Germantown	do	do	J. W. Groves	100	100	101		102	102			
No. 25 B	Bituminous; lump, over 1¾-inch screen.	do	do	do	do	do	100	100	101	101					
No. 26	Bituminous; run of mine	No. 5	Lincoln	Logan	Chicago and Alton.	do	102	103	103	104	104	104			
No. 27	do	No. 6	Auburn	Sangamon	do	do	104	105	105	106	106	106			
No. 28 A	Bituminous; size 5, washed	No. 7	Herrin	Williamson	Illinois Central	Uninspected	107	107	108					109	
No. 28 B	Bituminous; screenings, raw	do	do	do	do	do	107	107	108					109	
No. 28 C	Bituminous; lump, over 3-inch round shaking screen.	do	do	do	do	K. M. Way	107	107	108		108	108			
No. 29 A	Bituminous; screenings, through 2-inch shaking screen.	No. 5	Livingston	Madison		do	110	111	111		112	112	113	114	
No. 29 B	Bituminous; run of mine	do	do	do		do	110	111	111	112				114	
No. 30	Bituminous; nut, through 3-inch and over 2-inch shaking screen.	No. 7	Shiloh	St. Clair	Southern	do	115	115	116	116	117			117	
No. 31	Bituminous; screenings, over 1¼-inch shaking screen.	No. 6	Warden	do	Wabash	do	118	119	119					119	
No. 33	Bituminous; screenings, through 1½-inch shaking screen.	No. 7	Trenton	Clinton	Baltimore and Ohio.	do	120	121	121					121	
No. 34 A	Bituminous; screenings, over 1¼-inch shaking screen.	No. 5	Harrisburg	Saline	Big Four	do	122	123			123				
No. 34 B	Bituminous; run of mine	do	do	do	do	do	122	123	123		123	124			
Indiana:															
No. 1 B	Bituminous; screenings, through 1-inch screen.	No. 6	Mildred	Sullivan	Evansville and Terre Haute.	J. S. Burrows	125	125						125	
No. 5 B	Bituminous; screenings, through 1¼-inch bar screen.	No. 5	Hymera	do	do	Uninspected	126	126						126	

Samples of fuels received and tests made, by States—Continued.

Field number of sample.	Kind of fuel.	Name of bed.	Locality.	County.	Railroad.	Inspector.	Page of this report on which are discussed the—							
							Field work.	Chemical analyses.	Steaming tests.	Producer-gas tests.	Washing tests.	Coking tests.	Cupola tests.	Briquetting tests.
Indiana—Cont.														
No. 6 B	Bituminous; screenings, through 1¼-inch bar screen.	No. 4	Hymera	Sullivan	Evansville and Terre Haute.	Uninspected	127	127						127
No. 12	Bituminous; run of mine	No. 5	Hartwell	Pike	Southern	W. J. Von Borries.	128	128	129	129	130	130	130	
No. 13	do	No. 6	Terre Haute	Vigo	Vandalia	J. W. Groves	131	131	132	132				
No. 14	do	No. 3	Seelyville	do	do	F. B. Tough	133	133	134	134				
No. 15	do	No. 4	Linton	Greene	Southern Indiana	do	135	135	135	136				
No. 16	do	No. 5	do	do	Vandalia	J. W. Groves	136	137	137	137				
No. 17	do	do	Bicknell	Knox	do	do	138	138	139			139	139	
No. 18 A	Bituminous; washed slack, through ⅞-inch wire-mesh revolving screen.	do	Ayrshire	Pike	Southern	do	140	141				142		
No. 18 B	Bituminous; lump, over 1¾-inch round shaking screen.	do	do	do	do	do	140	141	141	142				
No. 19	Bituminous; screenings, through 1¼-inch stationary-bar screen	Brazil Block (top).	Diamond	Parke	Chicago and Eastern Illinois.	do	143	143	144					144
No. 20	do	Brazil Block (bottom).	Brazil	Clay	do	do	145	145			145			146
Indian Territory:														
No. 2 B	Bituminous; slack, through ⅝-inch shaking screen.	Hartshorne	Hartshorne		Rock Island	Uninspected	146	147	147		148			148
No. 2 C	Bituminous; lump, over 1-inch shaking screen.	do	do		do	J. W. Groves	146	147	147					149
No. 8	Bituminous	(?)	(?)		do	Uninspected	150	150	150		151			
No. 9	Semianthracite; run of mine	(?)	Panama		Kansas City Southern.	do	151	151	151					152
Kansas:														
No. 2 B	Bituminous; slack	Weir-Pittsburg.	Yale	Crawford	Missouri Pacific	do	153	153	153		154			155
No. 6	Bituminous; lump, over 1¼-inch bar screen.	do	Jewett	Linn	do	W. J. Von Borries.	156	156	156	157	157	158	158	
Kentucky:														
No. 2 B	Coke breeze		Earlington	Hopkins	Louisville and Nashville.		159				159			159
No. 8	Bituminous; run of mine	No. 1 B, or "Bell coal."	Sturgis	Union	Illinois Central	F. B. Tough	159	160	160			160	161	

No. 9 A	Bituminous; nut, through 1½-inch and over ⅜-inch screen.	No. 9	McHenry	Ohio	do	K. M. Way	162	162			163	163	163		
No. 9 B	Bituminous; run of mine	do	do	do	do	do	162	162	163						
Maryland No. 2	do	Pittsburg	Frostburg	Allegany	Baltimore and Ohio.	J. W. Groves	165	165	165						166
Missouri:															
No. 5	do	(?)	Higbee	Randolph	Chicago and Alton.	do	167	167	167		168	168	168		
No. 6	Bituminous; lump, over 6-inch bar screen.	(?)	Huntsville	do	Wabash	do	169	169	170						
No. 7 A	Bituminous; No. 1 nut	(?)	Novinger	Adair	Quincy, Omaha and Kansas City.	W. J. Von Borries	170	171	171		172				
No. 7 B	Bituminus; No. 2 nut	(?)	do	do	do	do	170	171	171		172				
No. 10	Bituminous; screenings, through ¾-inch shaking screen.	Bevier	Bevier	Macon	Chicago, Burlington and Quincy	K. M. Way	172	172	173						173
Montana:															
No. 2	Lignite	(?)	Fromberg	Carbon	Northern Pacific	N. H. Darton	174	174	175	175					
No. 3	do	(?)	Bridger	do	do	do	176	176	176	177					
New Mexico:															
No. 3 A	Bituminous; run of mine	Main Raton, or Lower Laramie.	Van Houten	Colfax	Atchison, Topeka and Santa Fe.	J. S. Burrows	177	178	178	179			180		
No. 3 B	Bituminous; lump, over ¾-inch screen.	do	do	do	do	do	177	178	178			179			
No. 3 C	Bituminous; slack, through ¾-inch screen.	do	do	do	do	do	177	178	178		179	179			
No. 4 A	Bituminous; run of mine	do	Brilliant	do	do	do	181	181	182	182	183				
No. 4 B	Bituminous; slack, through 1¼-inch screen.	do	do	do	do	do	181	181	182		183	183	183		
No. 5	Bituminous; run of mine	do	Blossburg	do	do	do	184	184	185	185	186	186	186		
Ohio:															
No. 10	Bituminous; lump, over 1¼-inch bar screen.	No. 5	Mineral City	Tuscarawas	Baltimore and Ohio; Pennsylvania lines.	J. W. Groves	187	187	188	188					
No. 11	do	No. 8	Flushing	Belmont	Baltimore and Ohio.	do	189	189	189	190					
No. 12	Bituminous; run of mine	do	Bellaire	do	Baltimore and Ohio; Pennsylvania lines.	K. M. Way	190	191	191	191	192	193			
Pennsylvania:															
No. 7	do	Pittsburg	Ligonier	Westmoreland	Ligonier Valley	do	193	194	194						
No. 11	do	do	Charleroi	Washington	Pennsylvania	J. W. Groves	194	195		195		195	196		
No. 12	do	do	Acheson	do	Baltimore and Ohio.	do	197	197		197	198	198	198		
No. 13	do	Freeport	Creighton	Allegheny	Pennsylvania	do	200	200		200					
No. 15	do	B, or Miller	Wehrum	Indiana	do	do	201	201	202	202	203	203			204
No. 16	do	D	Hastings	Cambria	do	K. M. Way	204	205	205	206					206
No. 17	do	Upper Freeport.	White	Indiana	do	A. K. Adams	207	207	208	208	209	209			
No. 18	do	B, or Miller	Lloydell	Cambria	do	K. M. Way	210	210	211						211
No. 19	do	Pittsburg	Herminie	Westmoreland	do	A. K. Adams	213	214	214			215			215
No. 20	do	Lower Kittanning.	Seward	do	do	J. W. Groves	216	216	217		217	218			2 S

Samples of fuels received and tests made, by States—Continued.

Field number of sample.	Kind of fuel.	Name of bed.	Locality.	County.	Railroad.	Inspector.	Page of this report on which are discussed the—							
							Field work.	Chemical analyses.	Steaming tests.	Producer-gas tests.	Washing tests.	Coking tests.	Cupola tests.	Briquetting tests.
Pennsylvania—Continued.														
No. 21	Bituminous; run of mine	Pittsburg	Connellsville	Fayette	Pennsylvania	A. K. Adams	219	219	....	....	....	220	220	....
No. 22	do	do	Huff	Westmoreland	do	J. W. Groves	221	221	221	222	....	....	....	222
Rhode Island No. 1.	Graphitic	(?)	Cranston	Providence	....	J. S. Burrows	223	223	224	....	....	263	....	204
Tennessee:														
No. 1	Bituminous; run of mine	Mingo	Fork Ridge	Claiborne	Louisville and Nashville.	W. J. Von Borries	224	225	225	226	226	226	227	228
No. 2	do	Log Mountain	Gatliff	Campbell	do	J. W. Grooves	228	229	229	230	....	230	230	....
No. 3	do	Regal Block	do	do	do	do	231	232	232	233	....	233	233	....
No. 4	do	Windrock, or Dean.	Oliver Springs.	Roane	do	do	234	235	235	236	....	236	237	237
No. 5	do	Brushy Mountain.	Petros	Morgan	Southern	do	238	239	239	240	240	240	241	....
No. 6	do	Lower Sewanee.	Waldensia	Cumberland	do	do	241	242	242	243	....	243	243	....
No. 7 A	Bituminous; screenings, over ¼-by 1-inch screen.	Wilder	Wilder	Fentress	do	do	244	245	245	246	....	....	....	....
No. 7 B	Bituminous; slack, through ¼- by 1-inch screen.	do	do	do	do	do	244	245	245	....	246	246	247	247
No. 8 A	Bituminous; special, run of mine.	First above Sewanee.	Clifty	White	Nashville, Chattanooga and St. Louis.	do	248	249	249	249	250	250	251	....
No. 8 B	Bituminous; screened, run of mine.	do	do	do	do	do	248	249	249	249	250	250	251	....
No. 9 A	Bituminous; lump, over ¾-inch screen.	Sewanee	Coalmont	Grundy	do	do	251	252	252	....	....	....	....	....
No. 9 B	Bituminous; raw slack	do	do	do	do	do	251	252	252	....	253	253	253	254
No. 9 C	Bituminous; washed slack	do	do	do	do	do	251	252	252	....	....	253	253	254
No. 10	Bituminous; slack	Battle Creek	Orme	Marion	do	W. J. Von Borries	255	255	255	....	256	256	256	256
No. 11	Bituminous; slack, through 1½-inch screen.	(?)	Ozone	Cumberland	Tennessee Central.	Uninspected	257	257	....	....	257	257	258	....
Texas:														
No. 3	Lignite; lump, over ¾-inch screen.	(?)	Olsen	Milam	International and Great Northern.	W. J. Von Borries.	258	259	....	259	....	....	....	....

No. 4	Lignite; run of mine	(?)	Hoyt	do	Missouri, Kansas and Texas.	do	260	260	260	261				261
Utah:															
No. 1	Bituminous; run of mine	(?)	Huntington Creek.	Carbon		Uninspected	262	262	224	262		263	263	263
No. 2	Bituminous; slack, through 1¼-inch screen.	Coalville, or Grass Creek.	Coalville	Summit	Union Pacific	J. W. Groves	264	265	265					265
Virginia:															
No. 5 A	Anthracite; pea	Big seam	Blacksburg	Montgomery	Norfolk and Western.	R. T. Carroll	267	267	267	268				
No. 5 B	Anthracite; slack	do	do	do	do	do	267	267	267					268
No. 6	Bituminous; run of mine	No. 4	Richlands	Tazewell	do	J. W. Groves	269	270	270	270	271	272		
Washington:															
No. 1 A	Subbituminous; pea	(?)	Renton	King	Seattle Electric	M. R. Campbell	272	272		273				
No. 1 B	Subbituminous; run of mine	(?)	do	do	do	do	272	272	273	273				
No. 2	Bituminous; lump	(?)	Roslyn	Kittitas	Northern Pacific	do	274	275	275	276		276	276	277
West Virginia:															
No. 11 B	Bone	Pocahontas No. 3.	Zenith	McDowell	Norfolk and Western.	J. W. Groves	278	278		278				
No. 16 A	Bituminous; ¾ inch	Pittsburg	Monongah	Marion	Baltimore and Ohio.	J. S. Burrows	279	279	279					
No. 22 A	Bituminous; screenings, through 1¼-inch screen.	(?)	Hernshaw	Kanawha	Chesapeake and Ohio.	J. W. Groves	279	280	280		281			
No. 22 B	Bituminous; run of mine	(?)	do	do	do	do	279	280	280					
No. 23 A	do	Cedar Grove	Monarch	do	Kanawha and Michigan.	do	281	281	282					
No. 23 B	Bituminous; slack, through 1¼-inch screen.	do	do	do	do	do	281	281	282		282			
No. 24	Bone	Pocahontas No. 3.	Gary	McDowell	Norfolk and Western.	A. K. Adams	282	283		282				
No. 25	Bituminous; lump, over 1¼-inch screen.	Black band	Charleston (8 miles southeast).	Kanawha	Chesapeake and Ohio.	J. W. Groves	283	283		283		284		
Wyoming:															
No. 4	Bituminous; run of mine	(?)	Hanna	Carbon	Union Pacific	do	284	284	285	285				
No. 5	do	Rock Springs.	Rock Springs.	Sweetwater	do	do	286	286		286		287		
No. 6	Subbituminous; run of mine	(?)	Kemmerer	Uinta	do	do	287	287	288	288				289
Miscellaneous:															
Coke, "miscellaneous."	Mixed coke						289	290		289				
Coke, "mixed."	do						290	290	290					
Collinsville, Ill.	Bituminous, nut		Collinsville	Madison	Vandalia	Uninspected	290	291	291					
Washery refuse.	Dumpings from washing tests on bituminous coals.						291	292	292					
No. 5	Coke breeze						292	292						293
No. 9	do						293	293						294
No. 10	Slack coal						295	295			295			

WORK OF THE CHEMICAL LABORATORY.

By N. W. Lord.

INTRODUCTION.

The principal work of the chemical laboratory for the period covered by this report consisted in making routine analyses and calorimetric determinations of the various coals tested at the fuel-testing plant. In addition to the regular work on coals, over 100 samples of pig iron from the cupola tests on cokes were analyzed for silicon, sulphur, and manganese. Complete analyses were made of several slags, also from the cupola tests. A large number of mine samples, sent into the laboratory by inspectors in different parts of the country, were analyzed.

A few special lines of research, involving a certain amount of additional analytical work, were also carried on at the plant, to study the characteristics of coals and to devise improvements in the methods of analysis employed. A report of this work is published in a bulletin of the Survey.[a]

EQUIPMENT.

The routine and special work has been carried on in the laboratory that was fitted up in the foundry building of the plant, as described in the report of the 1905 work.[b] The following additional equipment has been installed: A thermoelectric pyrometer, a number of extra platinum crucibles, and an arithmometer to facilitate the reduction and the tabulation of the results. The addition of a number of new filing cases and other new office furniture greatly facilitated the proper keeping of laboratory records.

CHANGES IN ANALYTICAL METHODS.

There has been only one change of moment in the methods used in the laboratory; this was in the method of determination of the "volatile matter" in lignites. The old method of analysis was the same as that used in the analysis of coals, and was found to give,

[a] Lord, N. W., Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, January 1, 1905, to July 31, 1906: Bull. U. S. Geol. Survey No. 323, 1907.

[b] See Bull. U. S. Geol. Survey No. 290, p. 29, 1906.

when applied to lignites, results which were too high, owing to the excessive moisture present. It was modified by introducing a short preliminary heating at a low temperature before applying the full heat of the burner. This procedure was found to make practically no difference in the results obtained with bituminous coals, while it gave much more concordant and satisfactory results when applied to lignites. The experiments on this subject and the comparison of results by both methods are treated in detail in Bulletin No. 323.

PERSONNEL.

Prof. E. E. Somermeier was associate chemist during the period; F. M. Stanton, head chemist; G. A. Burrell, first assistant, and Karl M. Way, E. C. Waters, and J. W. Peters, assistants. In April Mr. Waters resigned and was succeeded by J. A. McCalip, who resigned in September, being succeeded by D. I. Brown. Mr. Way was transferred to the field section in August and was succeeded by G. O. Spitler. R. C. Willis was added to the force in December and J. H. Birdsong in January, 1907.

WORK OF THE LABORATORY.

During the period covered by this report, 2,100 samples of coal have been received in the laboratory, representing 21 States, 2 Territories, and 2 foreign fields.

The proximate analysis and the determination of sulphur was made on practically all these samples, and on a large number of them the ultimate analysis and the determination of calorific value were also made. These determinations, with such other analyses as were made of special materials employed in the tests, involved more than 12,000 separate determinations.

The reduction of the results from the air-dried samples to the basis of condition as received, the calculation of the ultimate analyses and of the calorific values of the samples used in the steaming tests and the gas-producer tests, and the figuring of these results to the dry-coal basis were also performed by the laboratory force, involving practically the entire time of one man as a computer.

The analytical results are presented in the detailed report of tests on each sample. (See table, pp. 14–19.)

The analyses of mine and car samples given in this report are figured to the sample as received. In reporting the analyses of the coals used in steaming tests and all briquets, the proximate analysis is figured to the basis of coal "as received," but the ultimate analysis is figured on the dry-coal basis.

STEAMING TESTS.

By L. P. BRECKENRIDGE.

EQUIPMENT.

The equipment of the steam-boiler section consisted of two Heine water-tube boilers,[a] similar in construction and setting. The principal proportions of the boiler settings are as follows:

Leading proportions of the boilers installed at the fuel-testing plant.

	Boiler No. 1.	Boiler No. 2.
Rated capacity of boiler.....horsepower..	210	210
Water-heating surface.....square feet..	2,031	2,031
Superheating surface.....	None.	None.
Grate area.....square feet..	40.55	36.4
Air space through grate.....per cent..	45	35
Available stack draft.....inch of water..	.75	.75
Height of steel stacks.....feet..	115	115
Area of steel stacks.....square feet..	7.67	7.67
Number of 3½-inch tubes on each boiler.....	116	116
Usual steam pressure carried.....pounds..	80	80

Each boiler is provided with its own stack and fed by its own injector.

Boiler No. 1 was equipped with a plain grate and boiler No. 2 with the McClave rocking grate, but all the tests during the latter half of the period (tests 402–519) were conducted with a plain grate. Unless otherwise stated in the detailed report of steaming tests the plain grate was used. The furnace was of the Heine standard tile-roof type; no change was at any time made in the design.

PERSONNEL.

The following men were members of the steam-boiler section during the period covered by this report: Walter T. Ray, Henry Kreisinger, Harry W. Weeks, Charles H. Green, Robert H. Kuss, William M. Park, Fred Pahmeyer, Lloyd R. Stowe, R. H. Post, Ralph Galt, George S. Pope, G. E. Ryder, Fred W. Bird, Perry Barker, Lyman S. Weeks, Carl J. Fletcher, Clarence E. Woodman, and Charles E. Augustine. During the period Messrs. Green, Kuss, Park, Pahmeyer, Post, and L. S. Weeks resigned, and Messrs. Galt, Pope, and Ryder were assigned to other sections of the fuel investigations.

[a] See Prof. Paper U. S. Geological Survey No. 48, p. 301, and Bulls. U. S. Geol. Survey Nos. 261, p. 74; 290, p. 33; and 325, p. 173.

COALS TESTED.

In the scope of this report are included the results of 214 steaming tests on 106 coals from 23 domestic States and Territories and from Argentina, as follows:

Steaming tests made, by States.

Coal.	Number of tests.
Alabama:	
No. 2 B	3
No. 3	2
No. 4	5
No. 5	2
No. 6	1
Argentina No. 1	3
Arkansas:	
No. 7 A	2
No. 8	3
No. 10	1
Florida No. 1	1
Georgia No. 1	1
Illinois:	
No. 7 E	1
No. 9 C	2
No. 12 B	1
No. 19 C	2
No. 19 D	2
No. 19 E	2
No. 20	3
No. 21	3
No. 22 A	3
No. 23 A	4
No. 24 B	3
Nos. 25 A and 25 B (mixed)	2
No. 26	2
No. 27	2
No. 28 A	1
No. 28 B	1
No. 28 C	2
No. 29 A	1
No. 29 B	3
No. 30	1
No. 31	2
No. 33	1
No. 34 B	1
Indiana:	
No. 12	3
No. 13	2
No. 14	2
No. 15	2
No. 16	2
No. 17	2
No. 18 B	2
Indiana—Continued.	
No. 19	1
Indian Territory:	
No. 2 B	3
No. 2 C	1
Nos. 2 B and 2 C (mixed)	1
No. 8	1
No. 9	2
Kansas:	
No. 2 B	3
No. 6	2
Kentucky:	
No. 8	2
No. 9 B	1
Maryland No. 2	3
Missouri:	
No. 5	2
No. 6	2
No. 7 A	2
No. 7 B	1
No. 10	1
Montana:	
No. 2	1
No. 3	1
New Mexico:	
No. 3 A	1
No. 3 B	2
No. 3 C	1
No. 4 A	2
No. 4 B	1
No. 5	1
Ohio:	
No. 10	1
No. 11	2
No. 12	1
Pennsylvania:	
No. 7	1
No. 15	3
No. 16	2
No. 17	2
No. 18	2
No. 19	2
No. 20	2
No. 22	1
Rhode Island No. 1	1
Tennessee:	
No. 1	5
No. 2	3
No. 3	2
No. 4	3
No. 5	3
No. 6	3
No. 7 A	3
No. 7 B	1
Nos. 8 A and 8 B (mixed)	3
No. 9 A	3
Nos. 9 B and 9 C (mixed)	1
No. 10	2
Texas No. 4	3
Utah:	
No. 1 with Rhode Island No. 1	2
No. 2 with Rhode Island No. 1	1
No. 2	3
Virginia:	
No. 5 A	2
No. 5 B	1
No. 6	1
Washington:	
No. 1 B	1
No. 2	4
West Virginia:	
No. 16 A	2
No. 22 A	3
No. 22 B	1
No. 23 A	2
No. 23 B	2
Wyoming:	
No. 4	1
No. 6	2
Miscellaneous:	
Mixed coke	1
Collinsville	7
Washery refuse	1
	214

The detailed results of the steaming tests may be found by referring to the index table on pages 14–19. The results of eleven additional tests, run for special purposes during the period, are not included in this report, but will appear later, with discussions, and those of seven tests made during the period on coals received in 1905 are also reserved for future publication.

Many interesting conclusions are obtainable from the "boiler tests" so far made, but a discussion of them will require so much space that it has been decided to present all such conclusions, together with a large amount of experimental work, in a separate publication entitled "A Study of Four Hundred Steaming Tests."[a]

[a] Bull. U. S. Geol. Survey No. 325, 1907.

GENERAL RESULTS.

It is the purpose of the boiler section to make a careful detailed study of the process of combustion and heat absorption so as to determine what happens everywhere in the furnace with each individual coal, and thus to find the road which may lead to new methods of testing the burning qualities of coals, independently of the consideration of utilizing the heat and temperature thus produced. A large amount of such work has already been done and is discussed in the above-mentioned "Study;" for instance, the simultaneous taking of temperatures and samples for gas analysis at several points along the path of combustion, from the surface of the grate bars to the exit of the boiler. Such data are now at hand for many coals, but as the field of work is new it will be necessary to procure an enormous amount of information before any safe conclusions can be drawn. It is hoped that in the near future a very long combustion chamber will be built for special work of this kind.

One remarkable result of these investigations, discussed in the "Study," is an experimental proof, reached from several directions, of the correctness of a surmise sometimes made by engineers, that the efficiency of any individual boiler as a heat absorber does not change with the amount of fuel burned, but remains fairly constant. The trouble seems to be that ordinarily not as much heat as has heretofore been supposed comes into contact with the boiler because of incomplete combustion. This theory has lately been strengthened by routine analyses which have been run for hydrocarbons and free hydrogen in the flue gases, and which show some traces of large amounts of these combustible gases. The only mathematical deduction of this theory known to the writer is that made by John Perry in his book, "The Steam Engine and Gas and Oil Engines," page 591, in which he arrives at the following formula from the kinetic theory of gases and the laws of heat conductivity:

$$E = l - (e)^{-\frac{cl}{D}}$$

where E = efficiency of boiler as a heat absorber.

e = base of natural system of logarithms, 2.718.

c = a constant for any individual boiler, dependent on the general layout of the gas passages.

l = length of fire tube in any units.

D = internal diameter of fire tube in the same units.

Of course the above equation is deduced only for the case of one fire tube, clean inside and out, where there is no heat absorption due to radiation, but it ought to apply to any boiler, and the indications are that it does so apply, with suitable modifications of the constants, and that this true boiler efficiency is surprisingly constant in actual practice. It must be remembered, however, that these results are obtained from one plant necessarily limited in its scope of investigation.

PRODUCER-GAS TESTS.

By Robert H. Fernald.

EQUIPMENT.

During the period covered by this report the only change in the equipment of the producer-gas testing plant[a]—aside from minor changes in details leading either to higher efficiency or to greater ease in manipulation—has been the introduction of a crude but effective piece of apparatus for extracting the moisture from the tar. The apparatus operates by heating the tar moderately and stirring it very slowly, and consists of a corrugated-iron tank with a steam coil in the bottom and a 2-inch outlet for the tar about 6 inches from the bottom. The tank holds about 8 barrels of tar, and is provided with a stirring device driven by an electric motor at the rate of not more than five turns per minute. By means of this apparatus the moisture in the tar is reduced to about 10 per cent, but samples showing as low as 3 per cent have been procured, the amount of moisture left in the tar depending largely on the duration of the treatment.

PERSONNEL.

Capt. John A. Laird, a consulting engineer of St. Louis, who became connected with the plant in September, 1904, continued the supervision of the operating details of the tests until the first of November, 1906. He was assisted by J. P. Quam and Kurt Toensfeldt.

During the period from November 1 to December 15, 1906, C. O. Nordensson, who had formerly been connected with the plant, assumed the supervision, at the end of which period Mr. Quam gave up his connection with the Westinghouse Machine Company in order to devote his entire attention to this position. Mr. Nordensson and Mr. Quam were assisted by C. D. Smith and John Laichinger.

Until the latter part of June, 1906, Mr. Quam continued the direction of the operation of the gas engine. At that time he was called away from the testing plant by the Westinghouse Company, his place being taken by Clyde A. Gilmore. Messrs. Quam and Gilmore had as assistant engine operators R. E. Peshak until May 31, 1906; F. V. Roy until July 31, 1906; Curt Adler throughout the entire period; W. B. Lemmon after June 1, 1906; John Laichinger after July 18, 1906; and John Suter after November 1, 1906.

[a] See Bull. U. S. Geol. Survey No. 290.

W. C. Weidmann, who had been connected with the plant since September, 1904, continued in charge of the computations until April 5, 1907, and had as his assistant during the period covered by this report C. L. Armstrong. Upon the resignation of Mr. Weidmann, Lauson Stone was made head computer and Spencer Howell became his assistant.

The chemical work of the producer-gas tests has been under the supervision of H. A. Grine. He has had the following assistants: J. G. Goodwin until November 30, 1906; W. L. Hempelmann, July 1, 1905, to October 31, 1906; D. A. Barclay since November 1, 1906; J. K. Black since November 21, 1906; and H. M. Cooper since February 10, 1907.

January 1, 1907, a series of special investigations on small gas engines was begun. The details of these tests were placed in the hands of R. M. Strong.

The observations connected with the various tests have been made by L. A. Delano until November 30, 1906; S. P. Howell until transferred to the computing room; Julian Teza until March 1, 1907; W. J. Harris, jr., since February 19, 1906; E. C. Herrling since February 1, 1906; W. B. Lemmon, May 1, 1905, to May 31, 1906; H. C. Austin from July 20, 1906, to April 5, 1907; A. B. Bridgeman during June, 1906; J. C. Barnaby since January 1, 1907; L. C. Hopkins since January 1, 1907; B. W. Loye from January 1, 1907, to April 30, 1907; P. G. Weidner from January 1, 1907, to March 30, 1907; and D. F. Smith since November 15, 1906.

REGULAR AND SPECIAL TEST CONDITIONS.

The operating conditions have been maintained practically the same as during 1905. The regular schedule consists of two sixty-hour test runs per week. The first eight to twelve hours of each run are used for getting the fuel bed into uniform and efficient condition. Although records are taken during this preliminary period, the official test, as reported, includes only the last forty-eight or fifty hours of the run, during which time the conditions are maintained as uniform as possible.

One test, however, designated as "Producer-gas test 105," was carried far beyond the sixty-hour period, in order to establish beyond doubt the reliability of the gas producer and the gas engine. The report of this test (see p. 90), which was continued for 562 consecutive hours, will therefore be of special interest.

Tests on Massachusetts peat heretofore reported[a] were not entirely successful, because the amount furnished was sufficient only for a nine-hour test. It was demonstrated, however, beyond doubt, that the fuel would generate an excellent gas for power purposes.

[a] See Bull. U. S. Geol. Survey No. 290.

Subsequent to this test a liberal supply of peat from Florida was procured, sufficient to charge the producer properly, and an excellent full-time test (producer-gas test 117, see p. 77) was made on it, with no admixture of other fuel. The results were exceedingly satisfactory.

COALS TESTED.

During the period covered by this report, 69[a] producer-gas tests have been made on 61 coals from 16 States and 1 Territory, as follows:

Producer-gas tests made, by States.

Coal.	Number of tests.	Coal.	Number of tests.	Coal.	Number of tests.
Alabama:		Indiana—Continued.		Tennessee—Continued.	
No. 4	1	No. 18 B	2	No. 5	1
No. 6	1	Kansas No. 6	1	No. 6	1
Arkansas:		Montana:		No. 7 A	1
No. 7 A	1	No. 2	1	Nos. 8 A and 8 B mixed	2
No. 8	1	No. 3	1	Texas:	
No. 10	1	New Mexico:		No. 3	1
Florida No. 1	1	No. 3 A	1	No. 4	1
Illinois:		No. 4 A	1	Utah No. 1	1
No. 19 C	1	No. 5	1	Virginia:	
No. 21	1	Ohio:		No. 5 A	1
No. 22 A	1	No. 10	1	No. 6	1
No. 23 A	1	No. 11	1	Washington:	
No. 23 B	1	No. 12	2	No. 1 A	1
No. 24 B	1	Pennsylvania:		No. 1 B	2
No. 25 B	1	No. 11	1	No. 2	1
No. 26	1	No. 12	1	West Virginia:	
No. 27	1	No. 13	2	No. 11 B	1
No. 29 B	1	No. 15	1	No. 24	1
No. 30	1	No. 16	1	No. 25	1
Indiana:		No. 17	1	Wyoming:	
No. 12	1	No. 22	1	No. 4	1
No. 13	2	Tennessee:		No. 5	1
No. 14	1	No. 1	1	No. 6	1
No. 15	2	No. 2	1	Miscellaneous: Coke	1
No. 16	1	No. 3	1		
		No. 4	1		

The results of the producer-gas tests are given in brief on subsequent pages, and may be found by referring to the index table (p. 14).

SUMMARY.

In presenting the following brief summary of the tests made during the period covered by this report it has seemed desirable to compile the data in such form that a direct comparison could be made between the different types of fuel used. The fuels have therefore been divided into bituminous coals, lignites, bone coal, and peat. The results from peat are confined to those obtained from the single test on Florida peat, and might possibly be modified somewhat if they were averaged with results of several tests of peat from various sections of the country. The figures given for the mixture of tar, water, soot, etc., delivered by the tar extractor per ton of coal are very rough. Slight changes in the methods used in operating the plant will vary these figures considerably, although the results given represent fair average values.

[a] Four tests not included in this number were attempted, but the resulting data were insufficient to report.

Summary of results of producer-gas tests January 1, 1906, to March 1, 1907.

	Bituminous coal.				Lignite.				Bone coal.				Peat.
	Number of tests.	Average.	Maximum.	Minimum.	Number of tests.	Average.	Maximum.	Minimum.	Number of tests.	Average.	Maximum.	Minimum.	
Calorific value per pound of fuel {as fired ..... B. t. u.	56	12,232	14,170	10,013	10	8,887	10,685	6,356	2	9,555	10,545	8,566	8,127
Calorific value per pound of fuel {dry ..... do	56	13,062	14,524	11,547	10	11,467	12,798	10,492	2	9,733	10,861	8,606	10,289
Calorific value per cubic foot of standard gas from fuel ..... do	56	151.0	171.6	122.5	10	154.8	181.5	125.3	2	125.1	144.0	106.3	175.2
Gas per pound of fuel {as fired ..... cubic feet	38	61.0	94.0	45.5	3	40.3	45.9	31.9	2	60.4	76.8	44.1	30.3
Gas per pound of fuel {dry ..... do	38	64.9	96.4	51.3	3	48.1	50.1	47.1	2	61.8	79.2	44.3	38.3
Fuel, per square foot of fuel-bed area per hour {as fired ... pounds	42	7.35	10.50	4.67	5	11.18	13.25	8.46	2	7.77	9.82	5.72	15.2
Fuel, per square foot of fuel-bed area per hour {dry ..... do	42	6.84	9.30	4.56	5	8.72	9.30	7.74	2	7.66	9.77	5.55	12.0
Calorific value of gas per brake horsepower hour ..... B. t. u.	42	11,314	12,580	9,700	5	11,290	11,880	10,750	2	10,375	10,480	10,270	12,840
Equivalent fuel per electrical horsepower developed {as fired .. pounds	41	1.57	2.24	0.99	5	2.37	2.75	1.74	2	[a] 1.91	2.16	1.68	3.03
Equivalent fuel per electrical horsepower developed {dry ..... do	41	1.46	1.99	0.97	5	1.85	2.06	1.59	2	[a] 1.89	2.14	1.63	2.39
Ratio of total fuel used under boiler per electrical horsepower to total fuel used in gas producer per electrical horsepower	29	2.84	3.66	2.43	4	2.64	2.90	2.24	.....	.....	.....	.....	2.30
Mixture of tar, water, and soot delivered by tar extractor per ton of fuel:													
After water separator was installed ..... pounds	15	308	624	92	2	224	338	110	.....	.....	.....	.....	157
Before water separator was installed ..... do	3	193	396	52	6	220	289	118	.....	.....	.....	.....	.....
Composition of fuel:													
Moisture ..... per cent	56	6.48	14.77	1.62	10	22.84	39.43	8.51	2	1.69	2.91	0.47	21.00
Volatile matter ..... do	56	32.21	42.46	9.70	10	31.77	37.18	25.54	2	10.32	11.81	8.83	51.72
Fixed carbon ..... do	56	50.23	69.01	38.81	10	35.11	45.69	24.37	2	52.08	57.19	46.96	22.11
Ash ..... do	56	11.08	20.57	3.70	10	10.28	15.39	2.74	2	35.91	43.74	28.08	5.17
Sulphur ..... do	56	2.30	5.14	0.28	10	0.57	0.88	0.47	2	0.41	0.54	0.27	0.45
Composition of gas produced (volumetric):													
Carbon dioxide (CO_2) ..... do	47	9.9	12.2	7.9	7	10.8	13.2	8.0	1	9.7	.....	.....	12.4
Oxygen (O_2) ..... do	47	0.0	0.1	0.0	7	0.2	0.7	0.0	1	0.0	.....	.....	0.0
Carbon monoxide (CO) ..... do	47	19.2	23.4	16.4	7	18.8	23.2	13.9	1	19.5	.....	.....	21.0
Hydrogen (H_2) ..... do	47	15.0	20.5	12.6	7	15.4	19.3	12.8	1	16.6	.....	.....	18.5
Methane (CH_4) ..... do	47	02.2	2.9	1.0	7	2.6	3.3	1.7	1	1.6	.....	.....	2.2
Nitrogen (N_2) ..... do	47	53.2	57.2	48.2	7	51.8	57.4	46.5	1	52.6	.....	.....	45.5
Ethylene (C_2H_4) ..... do	47	0.5	0.7	0.1	7	0.4	0.7	0.0	1	0.0	.....	.....	0.4

[a] Estimated. The actual average amount of bone coal consumed in the producer per electrical horsepower hour was 1.71 pounds as fired and 1.69 pounds of dry coal. It is estimated that the equivalent of this coal required to make the steam used in the producer was 0.2 pound per electrical horsepower hour.

WASHING TESTS.

By G. R. DELAMATER.

INTRODUCTION.

During the first six months of the period covered by this report the washing tests were conducted under the direction of John D. Wick, assisted by Edward Moore. J. H. Gould was in charge of the tests from July 16, 1906, to October 13, 1906, and G. R. Delamater was in charge from November 15, 1906, throughout the balance of the period.

EQUIPMENT AND OPERATION.

The Stewart jig used during 1905[a] was employed in making all tests until February 22, 1906, when the washer plant was almost entirely destroyed by fire, and with it a few samples of coal that were stored in the bins. The plant was immediately rebuilt, and similar equipment and methods were used for the tests made till November 15, 1906.

During December, 1906, a special jig was installed. This jig was of the center-plunger type; that is, the plunger was directly beneath the screen, and its upward stroke caused the pulsation. The plunger had no valves, but instead valves were arranged in the sides of the jig body to admit the water supply on the downstroke of the plunger. Cams and springs were so arranged that the plunger had a slow downward and a quick upward stroke. The screen of this jig was 4 by 5 feet in area and was made of strips of No. 10 wire running lengthwise of the screen frame and set one-sixteenth of an inch apart. The length of stroke was adjustable up to 4 inches. The depth of the coal bed was also adjustable.

Owing to the fact that the power for operating the washer plant was furnished by a 12 by 16 inch Frost steam engine, belted to a main shaft from which the jigs and other machinery were driven; it was impossible to change the speed of the jigs. Better results could have been obtained on some coals tested had it been possible to change the speed to suit the length of stroke used.

[a] Bull. U. S. Geol. Survey No. 290, 1906, p. 31.

As the only crusher available for this work was an 18 by 24 inch Cornish tooth-roll crusher, it was impossible to crush some coals as fine as was desirable. However, an adjustable-mesh bumping screen was installed in January, 1907, in such a manner that the coal was first passed over this screen and the tailings then passed on to the crusher, while the coal which went through the screen dropped into the bin over the jig. The product of the crusher was then elevated again to the screen, and this cycle of operation was repeated until all the coal passed through the screen.

In December, 1906, a "float and sink" testing equipment was installed. Before each washing test was made samples of the raw coal, quartered down to 2 kilograms each, were tested on four different specific-gravity solutions. In this manner it was possible to make a preliminary determination of the result of a separation under varying percentages of washed coal and refuse, and the coal was then washed with the jig regulated to discharge, as refuse, a percentage about equal to the percentage found advisable from the float and sink tests. After a washing test was made a sample of the refuse was taken and quartered down to four samples of 2 kilograms each, and these were also tested on the specific-gravity solutions. The test showing the highest percentage of float coal and having an analysis which agreed fairly with that of the washed coal was then used in determining the percentage of loss of good coal in the refuse. In this manner the efficiency of the test was shown.

EXPLANATION OF THE WASHING-TEST DATA.

The only parts of the washing-test tables requiring explanation are the "Per cent reduction" and "Amounts actually removed" as given in the note accompanying the tables. The per cent of reduction is obtained by comparing the percentages of impurities in the raw coal with those in the washed coal. It will be readily understood that if the ash alone be reduced by washing the fixed carbon and volatile matter will show a higher percentage in the washed coal than in the raw coal. However, in actual practice it is impossible to make so perfect a separation that there will be no portions of constituents other than the impurities removed in washing, and therefore the percentage of any one constituent in the washed coal is affected by the reduction of each of the other constituents. This is clearly indicated in test 192, on Alabama No. 6 (see p. 60), and in test 198, on Virginia No. 6 (see p. 271). By comparing the analyses of raw and washed coal in test 192 we find the same percentage of sulphur in the washed coal as in the raw coal, and in test 193 the sulphur in the washed coal is higher than it was in the raw coal. It will therefore be seen that a simple comparison of the analyses of raw and washed coal does not always show whether any of the sulphur in the raw coal was actually removed with the refuse in washing.

In order that this point might be determined, the following formulas were derived and used in making up this report. It will be noted by referring to the test data that in test 192 (p. 60) 10 per cent of the original sulphur in the raw coal was removed with the refuse in washing, and in test 198 (p. 271) 13 per cent of the original sulphur was removed.

Let X = the percentage of reduction of any constituent.
Y = the percentage of the constituent removed by washing.
M = the percentage that the amount of the constituent in the washed coal is of the amount in 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—

$$X = \frac{c-b}{c} \qquad M = ab \qquad Y = \frac{c-M}{c}$$

COALS TESTED.

During the period covered by this report[a] 61 washing tests were made on 57 coals from 14 domestic States and Territories and Argentina, as follows:

Washing tests made, by States.

Coal.	Number of tests.	Coal.	Number of tests.	Coal.	Number of tests.
Alabama:		Illinois—Continued.		New Mexico—Continued.	
No. 2 B	1	No. 29 A	2	No. 5	1
No. 3	1	No. 30	2	Ohio No. 12	1
No. 4	1	No. 34 A	1	Pennsylvania:	
No. 5	1	No. 34 B	1	No. 12	1
No. 6	1	Indiana:		No. 15	1
Argentina No. 1	2	No. 12	1	No. 17	1
Arkansas:		No. 20	1	No. 20	1
No. 1 B	1	Indian Territory:		Tennessee:	
No. 7 B	1	No. 2 B	1	No. 1	1
No. 8	1	No. 8	1	No. 5	1
No. 9	1	Kansas:		No. 7 B	1
Illinois:		No. 2 B	2	Nos. 8 A and 8 B mixed	1
No. 20	1	No. 6	1	No. 9 B	1
No. 21	1	Kentucky:		No. 10	1
No. 22 A	1	No. 2 B	1	No. 11	1
No. 22 B	1	No. 9 A	1	Virginia No. 6	1
No. 23 A	1	Missouri:		West Virginia:	
No. 23 B	1	No. 5	1	No. 22 A	1
No. 24 A	1	No. 7 A	1	No. 23 B	1
No. 24 B	1	No. 7 B	1	Miscellaneous No. 10	1
No. 25 A	1	New Mexico:			61
No. 26	1	No. 3 C	1		
No. 27	1	No. 4 A	1		
No. 28 C	1	No. 4 B	1		

The detailed results of the washing tests may be found on the pages referred to in the index table (pp. 14–19).

[a] Besides these tests, two tests not reported herein were made, as follows: Tests 155 and 154, Missouri Nos. 6 and 7, respectively (coal burned in the fire at the plant).

COKING TESTS.

By A. W. BELDEN.

INTRODUCTION.

The coking tests for the period covered by this report were made in the two beehive ovens that were employed in the 1905 tests, and the method of procedure was the same.[a]

The personnel of the section remained the same, the writer being assisted by W. E. Vickers, of Pocahontas, Va.

COALS TESTED.

In the scope of this report, covering the period from January 1, 1906, to February 20, 1907, are included results from 98 coking tests on 57 coals from 17 States and 1 Territory, as follows:

Coking tests made, by States.

Coal.	Number of tests.	Coal.	Number of tests.	Coal.	Number of tests.
Alabama:		Indiana:		Tennessee:	
No. 2 B	1	No. 12	3	No. 1	2
No. 3	2	No. 17	1	No. 2	1
No. 4	2	No. 18 A	2	No. 3	1
No. 5	1	Kansas No. 6	2	No. 4	2
No. 6	2	Kentucky:		No. 5	1
Arkansas:		No. 8	2	No. 6	1
No. 1 B	4	No. 9 A	1	No. 7 B	2
No. 7 B	2	Missouri No. 5	1	No. 8 B	1
No. 9	5	New Mexico:		No. 9	1
Georgia No. 1	1	No. 3 C	2	No. 10	1
Illinois:		No. 4 B	2	No. 11	1
No. 20	2	No. 5	2	Utah:	
No. 21	2	Nos. 3 C, 4 B, and 5 mixed	1	No. 1	1
No. 22 B	2	Ohio No. 12	1	No. 1 (with Rhode Island No. 1)	2
No. 23 A	1	Pennsylvania:		Virginia No. 6	2
No. 23 B	2	No. 11	1	Washington No. 2	1
No. 24 A	2	No. 12	2	West Virginia No. 25	1
No. 24 B	1	No. 15	2	Wyoming No. 5	1
No. 25 A	2	No. 17	2		
No. 26	1	No. 19	2		98
No. 27	1	No. 20	2		
No. 28 C	1	No. 21	5		
No. 29 A	2				
No. 34 B	1				

Of these 98 tests, 39 were made on raw coal, 51 on washed coal, 5 on washed coal with the addition of pitch, 1 on washed coal with the addition of asphalt, and 2 on raw coal with the addition of graphitic coal low in volatile matter.

[a] See Bull. U. S. Geol. Survey No. 290, 1906.

Of the 57 different coals, 4 produced no coke, viz, Illinois No. 21, Illinois No. 24 A, Indiana No. 18 A, and Wyoming No. 5.

Two efforts were made (tests 141 and 157) to improve coke from Utah No. 1, by mixing with this coal 33⅓ per cent and 25 per cent, respectively, of Rhode Island No. 1, a graphitic coal containing 4.92 per cent volatile matter, the idea being to reduce the volatile matter to approximate that contained in good coking coal. In the test 141 no coke was produced; test 157 gave 3,504 pounds of very inferior coke, and 3,208 pounds of breeze (p 263).

The results of the coking tests may be found in the detailed report of each sample presented on the following pages.

FUTURE WORK.

It has been decided to move this section of the plant to Denver, Colo., in order to take up the question of producing coke from western coals and to experiment further with the addition of volatile hydrocarbons to noncoking coals and to coals producing an inferior grade of coke. Tests will also be made with the mixing of coals, and different degrees of fineness of crushing. The scope of the work will be extended to include by-product coke.

CUPOLA TESTS ON COKE.

By RICHARD MOLDENKE.

EQUIPMENT.

Owing to the removal of one of the cupolas which served for the tests on foundry coke during the Louisiana Purchase Exposition, all the tests made since then were conducted in the 36-inch Whiting foundry cupola. The 36-inch shell was relined to 26 inches internal diameter. There were four horizontal tuyeres 11 inches above the sand bottom, and the total tuyere area was 96 square inches, giving a ratio with the cupola area of 1 to 5.96. By training the crew properly it was possible to run off two heats a day without interruption.

PERSONNEL.

The cupola tests were conducted by W. G. Ireland, under the direction of A. W. Belden, the coke expert of the Geological Survey, and with the advice of Dr. Richard Moldenke, in charge of the cupola tests of the fuel-testing plant.

METHOD OF TESTING.

The method of testing has been fully described in the report of the fuel-testing plant for 1904.[a] It was sometimes necessary to vary the proportion of scrap to pig iron, according to the supply toward the end of the tests, but the total amounts were kept correct as planned for the general series of tests.

After completing the tests on the available cokes in the regular way, so that the results might be comparable with the previous work of the section, a further series of tests was made on some of these cokes. In these tests the bed coke was not kept at a constant height above the tuyeres, but the carbon content was calculated from the analysis of the particular coke, and a sufficient amount taken to make up 175 pounds of carbon, regardless of the height above the tuyeres. The results, which show interesting features, are withheld for a publication

[a] Prof. Paper U. S. Geol. Survey No. 48, pt. 3, 1906, pp. 1367–1370.

dealing with coals received during 1905. Some cokes gave better melting ratios and melting rates per hour than with the ordinary test methods and others gave inferior results. The tests were made to show the advisability, on the part of the manufacturer as well as of the foundryman, of studying the conditions of cupola practice with a view to adopting those methods which give the best results.

COKES TESTED.

The results of 69[a] cupola tests on 33 different cokes made from fuels from 11 States and 1 Territory are included in this report. Many of these tests are on washed samples, and several of the tests were repeated in order to get more satisfactory results. The origin of the samples and the number of tests made are as follows:

Cupola tests made on coke, by States.

Coal.	Number of tests.	Coal.	Number of tests.	Coal.	Number of tests.
Alabama:		Missouri No. 5	1	Tennessee—Continued.	
No. 2 B	2	New Mexico:		No. 6	2
No. 3	3	No. 4 B	1	No. 7 B	2
No. 4	4	Nos. 3 B, 4 B, and 5 mixed	2	Nos. 8 A and 8 B mixed	2
Arkansas:		No. 5	1	Nos. 9 B and 9 C mixed	2
No. 1 B	2	Pennsylvania:		No. 10	2
No. 7 B	2	No. 11	2	No. 11	2
No. 9	2	No. 12	6	Utah No. 1	1
Illinois:		No. 21	1	Washington No. 2	2
No. 22 B	1	Tennessee:			69
No. 29 A	3	No. 1	3		
Indiana:		No. 2	2		
No. 12	1	No. 3	2		
No. 17	1	No. 4	3		
Kansas No. 6	1	No. 5	2		
Kentucky:					
No. 8	3				
No. 9 A	3				

The detailed results of the standard series of tests on these cokes may be found by referring to the index table (pp. 14–19).

[a] This number does not include the tests on fuels received during 1905, many of which were conducted during this period. These tests are reserved for future publication.

BRIQUETTING TESTS.

By C. T. MALCOLMSON.

INTRODUCTION.

During the latter part of 1905 tests were conducted[a] on briquets made in the briquetting machine built by William Johnson & Sons, Leeds, England, and hereinafter called the "English" machine. No attempt was made to obtain data on these tests other than superficial observations on combustion. The results were entirely satisfactory, and it was therefore decided to continue, during 1906, to make briquets from the surplus of samples of coal sent to the plant, in order to substantiate with practical tests the conclusions reached from laboratory experiments made during the previous year.

PERSONNEL.

On January 1, 1906, the writer was instructed to proceed with these investigations. W. J. Chapman was placed in charge of the operation of the machines, making the briquets used in the tests and assisting as observer in obtaining the accompanying data, and Robert Strasser, of Vienna, was placed in charge of the chemical laboratory of this section. To this staff were added G. E. Ryder, in charge of locomotive tests, assisted by Ralph Galt as gas chemist and computer and C. W. Vocke as observer; also C. L. Wright, in charge of physical tests.

EQUIPMENT.

The work of briquetting the samples already reported for other tests made during 1905[b] was barely started when the briquetting plant and all stored briquets and fuels were entirely destroyed or ruined by fire. In rebuilding the plant, provision was made for the installation of an experimental briquetting machine of the plunger type, built in St. Louis after several years of experimentation and known herein as the "Renfrow" machine. The fundamental difference between it and the English machine is that the Renfrow machine

[a] Bull. U. S. Geol. Survey No. 290, 1906, pp. 40-52.
[b] Bull. U. S. Geol. Survey No. 290, 1906.

makes briquets at each end of the stroke of the plunger. By this design the briquets are kept under compression in the dies twice as long for the same output as they are in machines of the English type. The same length of time for compression being assumed, however, and other conditions being equal, the Renfrow machine has double the output of other plunger-type machines. The period of compression is determined by experience and fixes the speed of the machine. The longer the pressure remains on the warm charge the greater the cohesion and the better the briquet, but the smaller the output.

Twelve briquets are made on the Renfrow machine at each end of the stroke, or 24 in each revolution. At 12 revolutions per minute the output was 4 tons per hour, on an average, for all fuels. The machine was successfully operated at 16 revolutions per minute with a relatively increased capacity, but the lower speed was better adapted to the experimental work. The pressure obtainable under ordinary working conditions never exceeded 1,000 pounds per square inch, whereas a pressure of 2,000 to 2,500 pounds per square inch is considered necessary to make satisfactory briquets. For this reason it was found necessary to use a softer pitch and a greater percentage of binder than on the English machine, in order to make good briquets. The fault was somewhat obviated on the Renfrow machine by the jacketed heaters, which made it possible to control absolutely the moisture content. Advices have been received that the Renfrow Company has begun the construction of a new machine capable of producing higher pressure, and much stronger and heavier in every way. The briquets will be 3¼ inches in diameter and will weigh 12 ounces each.

The English machine was not seriously damaged by the fire, but in repairing it considerable care was taken to strengthen certain parts, to provide better lubrication and alignment, and to replace the tight and loose pulleys with friction clutches. The new plant was first operated in May, 1906, and as a result of previous experience it contained some improvements in the methods of crushing, mixing, and conveying the fuel, and of preparing the fuel and binder before briquetting. The new auxiliary equipment for the two machines was not materially different from that originally belonging to the English machine.[a]

The foundation of the Stedman disintegrator was raised to a level with the floor so as to be more accessible. A storage bin of 40 tons capacity, divided into four equal compartments, was built sufficiently high above the charging floor to allow coal to be drawn by gravity into the hopper scales placed on this floor. A pitch cracker was so placed beside the scales that pitch from it and coal from the scales could pass uniformly to a mixing conveyor directly under the charging floor and be discharged into the disintegrator on the floor below. By

[a] Prof. Paper U. S. Geol. Survey No. 48, 1906, p. 1392; Bull. U. S. Geol. Survey No. 290, 1906, p. 40.

this arrangement small samples of coal and binder could be turned on the charging floor and fed by hand into the conveyor through a hole in the floor. A bucket elevator and a divided chute provided with a gate served to convey the fuel from the disintegrator either to the agglomerating cylinder of the English machine or to the storage bin built above and directly behind the Renfrow machine. This bin contained an agitator to prevent the fine fuel from packing. The fuel was carried from the bin to the hoppers of the Renfrow machine by belt conveyors, the amount delivered being regulated by gates in the bottom of the bin. Provision was made for the use of either liquid or hard pitch as a binder for briquets made on the Renfrow machine. During the hot weather considerable difficulty was experienced in conveying the finely divided and thoroughly mixed coal and pitch from the disintegrator to the Renfrow machine. This difficulty was obviated by introducing the melted hard pitch into the coal as it entered the hoppers of the machine, care being taken to maintain uniform temperature and rate of flow of the pitch.

The bronze bushings of the dies in the Renfrow machine were renewed toward the end of the period, and it was thought advisable to place heavier springs behind the plungers, as those in the machine when it was installed had been badly jammed and weakened by double charges. Similar renewals were made on the English machine, in which all of the partition walls of the bronze bushings were cracked, owing to improper alignment of the plungers and unequal loading of the dies.

The necessity of maintaining a comparatively large force of common laborers about the plant for careful handling of samples, both in the raw and briquetted form, justified the use of more labor in the actual briquetting operations than would be found in a commercial plant. The thorough cleaning of all conveyors, bins, and auxiliary apparatus before briquetting each sample was of as much importance for comparative results as the actual briquetting of the fuel; consequently no attempt was made to develop mechanical means for doing this work.

THE BRIQUETS.

DESCRIPTION.

The essential differences between finished briquets from the English and Renfrow machines are (1) the shape, (2) the size, and (3) the cohesion of the warm briquet.

The English briquet is rectangular, $4\frac{1}{4}$ by $6\frac{3}{4}$ inches, and averages $2\frac{3}{4}$ inches in thickness and $3\frac{1}{2}$ pounds in weight. The Renfrow briquet is made in biscuit shape, being a short cylinder 3 inches in diameter, having rounded ends, the thickness between the ends ranging from $1\frac{1}{2}$ to 3 inches according to the fuel. The average weight is 8 ounces.

The difference in cohesion of these two briquets as they come from the machine is due mainly to the method of treating the fuel before compressing it into briquets. In the English machine a charge is fed into the agglomerating cylinder, where it is heated by passing steam through the mass, superheated steam being used if the coal is high in moisture. The finished briquet consequently contains an excess of moisture, which retards hardening and necessitates careful handling until the briquets become cold. In the treatment of fuel for the Renfrow machine, uncombined moisture is reduced to as low a point as practicable. The mixing of the mass is accomplished uniformly and continuously in jacketed cylinders, using superheated steam. Toward the end of this process the moisture content is raised to the amount requisite to make good briquets by the admission of wet steam or water, according to the temperature of agglomerate desired at the dies. By this means the moisture in the briquet is kept constant and at a minimum. The briquets are sprayed with water on ejection from the dies, and on delivery from the machine are sufficiently hard to be handled by coke forks and loaded for shipment.

BINDERS USED.

In accordance with the practice well established in Europe and the results of the laboratory experiments of the previous year, no binder has been considered except two of the pitches derived from the distillation of the tar obtained as a by-product in the manufacture of illuminating gas. The large and increasing use in this country of illuminating gas made by carburetting water gas with oil suggested the use of the pitch thereby obtained, which is known in this report as water-gas pitch (abbreviated to w. g. p.). The other pitch used is that derived from the destructive distillation of coal, and is here called coal-tar pitch (abbreviated to c. t. p.). The pitch derived from by-product coke ovens was not considered, on account of the small number of these ovens in this country. In order to obtain data which would be comparative, all briquets in any one lot were made with the same binder. The binder was as nearly uniform as would be found practicable in commercial operations where the quality of the pitch could not be absolutely controlled.

QUALITY OF PITCH.

No effort was made to determine the best quality of binder for each coal, or for each machine, because of the small amounts of the samples available. On account of the relatively low pressure obtainable on the Renfrow machine, the binder the smallest percentage of which was required to make briquets with satisfactory physical properties proved to be pitch just hard enough to be broken easily in the pitch cracker, while pitch from which more of the heavy oils had

been distilled produced less smoke. The hardness of the binder was determined by a compromise between these two factors. From 6 to 8 per cent of binder was used.

The "flowing test" for determining the hardness of the pitch was made in the following manner: The bulb of the thermometer was covered with a thin layer of melted pitch, which was allowed to harden. The thermometer was passed through a cork fitted in the mouth of a test tube, which held the bottom of the thermometer bulb 2 inches from the bottom of the tube. The test tube was then held in a vertical position in a beaker of boiling water. As the pitch became soft it gradually dropped from the thermometer in the form of a thread, and the temperature recorded when this thread reached the bottom of the test tube was called the "flowing point."

A fractional distillation of the pitch was made as another check on its quality. From this distillation the oils coming off under 572° F., between 572° and 680° F., and between 680° and 743° F. were recorded. The most reliable test that was found for determining the binding property of a pitch has already been described.[a] Pitch that at the temperature of the mouth could be bitten nearly through before breaking proved the most satisfactory binder for most coals briquetted.

The results of the tests on binders are given in the following table:

Tests and analyses of pitch binders.

Laboratory No.	Calorific value (B.t.u.).	Flowing point (°F.).	Oils by distillation (per cent).				Extraction analysis: Pitch extracted (sample as received) by CS_2 (per cent).
			Up to 572° F.	572° to 680° F.	680° to 743° F.	Total up to 743° F.	
2735	.....	186.8	Data lost in fire				58.56
2729	.....	255.0	.....do				61.20
2748	.....	144.0	.....do				89.20
2933	15,937	176.0	.....do				64.20
3258	16,373	179.6	3.66	12.30	15.23	31.19	80.27
3296	16,427	171.5	3.08	11.57	11.82	26.47	82.43
3410	16,478	175.1	.85	15.21	9.11	25.17	79.98
3486	16,407	186.8	1.75	6.00	17.00	24.70	85.57
3623	16,027	165.2	.85	11.15	10.15	25.15	69.26
3624	16,193	172.4	1.25	10.35	9.40	20.00	99.60
3692	16,103	158.0	1.89	10.90	1.03	22.82	69.71
3885	16,870	140.0	1.43	14.83	18.18	34.44	95.20
3962	16,196	159.8	3.00	12.75	10.75	26.50	77.79
4120	17,060	154.4	.75	11.25	17.25	29.25	97.70
4318	16,744	165.2	1.00	11.10	13.50	25.60	90.42
4319	16,139	158.0	2.75	10.35	9.90	23.00	66.25
4543	16,969	143.6	1.62	17.31	20.12	39.05	99.66
4625	16,576	156.2	1.61	9.56	14.30	25.47	90.56
4683	16,637	161.6	1.28	11.64	16.06	28.98	89.31
4806	16,864	143.6	1.09	9.44	15.23	25.76	96.90
4825	17,156	114.8	.46	1.05	4.25	5.76	100.00
4879	16,805	125.6	1.33	16.53	15.15	33.01	94.50

[a] Prof. Paper U. S. Geol. Survey No. 48, pt. 3, 1906, p. 1396.

PERCENTAGE OF BINDER.

In handling a given sample of coal various percentages of binder were used in briquetting lots of 600 pounds. The remainder of the coal was briquetted with the minimum percentage of binder found necessary to make a satisfactory briquet. In all cases the fuel and binder were both weighed separately, and the percentages of binder given are taken from these figures. The extraction analyses by carbon bisulphide, the results of which are given in the above table, were made from carefully selected samples of coals, pitches, and briquets, and the percentage of binder in the finished product was calculated from these determinations.

SAMPLING AND DRYING.

A majority of the coals sent in for briquetting tests only were slack coals and were unloaded on the ground. Unless these samples had been subjected to heavy rains they were taken direct to the briquet bins. Washed samples, very wet slack, and coals high in moisture were passed through the direct-heat rotating drier furnished by the C. S. Snow & Bartlett Company. In some cases, where the moisture content was very low, so that it was necessary to add considerable water to the coal, the water was added before grinding, samples for moisture being taken during the course of the day's run. Ordinarily, however, the coals and the binder were sampled as they were fed into the disintegrator. The steaming-test analyses of briquets were used where possible and are given in this report. When no steaming tests were made, the samples for analyses were taken as the briquets left the machine. All briquets shipped from the plant for test were sampled as loaded and not as taken from the machine.

TESTS ON BRIQUETS.

COMBUSTION TESTS.

The only method available for determining the relative heating values of briquets consisted in burning them under boilers, the conditions being uniform with those for the steaming tests on coals. These tests were made by the boiler section in every case where there was a sufficient number of briquets, and are reported under "Steaming tests" in this bulletin. When coal was not available to make enough briquets on each machine, with the same percentage of binder, for a complete steaming test on both the English and Renfrow briquets, the test was divided into five-hour runs on each machine.

Several small lots of briquets containing various percentages of binder were burned under the boiler to note the behavior of the bri-

quets in the fire and the effect on quantity of smoke, but the main test was on briquets of a uniform percentage of binder. In many tests it was necessary to break up the English briquets in order to obtain capacity on the boiler, although every effort was made to burn them unbroken for comparative results.

Besides these tests on briquets at the plant, two series of tests were run—one using the briquets in locomotive boilers, and the other in boilers for house heating. In the detailed reports given in this volume tests from which the briquets were used in locomotives are indicated by a star (*) attached to the test number, and those from which the briquets were used in house boilers by a dagger (†). In many tests the product was divided, part being used for a house test and part for a locomotive test. The reports on these special tests are reserved for publication in a subsequent bulletin.

DROP TESTS.

An effort was made to obtain reliable data on the crushing strength of the various briquets. After repeated trials on selected briquets from several runs, the record was abandoned, as the results from briquets made of the same coal and under similar conditions did not check. Briquets taken at random from the same lot differed widely. The following method of testing the strength of the briquets, called the "drop test," was chosen as an approximation of the handling to which they would be subjected in commercial use. A box, 24 inches square and 12 inches deep, was constructed with a bottom consisting of two trapdoors hinged at the sides and so closed as to be easily tripped open. This box was supported 6½ feet above a cast-iron plate, which was placed at the bottom of a second box 12 inches deep. Fifty pounds of briquets, placed in the upper box, were suddenly dropped upon the cast-iron plate. The mass was then screened on a 1-inch mesh wire screen, and all the pieces held were again dropped from the box; and so on until the dropping had been performed five times. The percentage of the weight of the pieces held at the last screening to the original weight of the briquets was called "per cent held by 1-inch screen," and the remainder was called "per cent through 1-inch screen."

TUMBLER TESTS.

The tumbler tests were chosen to obtain a fair record of the cohesion of the briquets, especially when subjected to abrasive action. The method used follows closely the one adopted by the French navy and used as a standard in France. The apparatus consisted of a tumbler manufactured by the S. Obermayer Company. A number of whole briquets weighing as near 50 pounds as possible

were placed in the tumbler and rotated for two minutes at a uniform speed of 28 r. p. m., after which the contents of the tumbler were screened through a 1-inch mesh screen and the finest again screened through a 10-mesh sieve. The pieces held by both screens were weighed and the data in the tables determined by these weights.

WEATHERING TESTS.

Small piles of all briquets made were labeled and placed in a yard exposed to the weather. Although all the briquets have not had uniform weather conditions, the length of the exposure is a fair basis for comparison. As no ideal briquet is available as a standard for comparison, it is difficult to give in a concise statement the actual condition of these briquets. The following is the key to the designation of condition given under "Weathering test:"

Condition A: Briquets practically in same condition as when put out. Surfaces show no signs of erosion or pitting. Briquets hard, with sharp edges, and fracture same as that of new briquets.

Condition B: Shape of briquets unchanged. Surfaces of those on top of pile have lost luster, with evidences of pitting; corners and edges worn off by erosion. All briquets firm, with fracture practically the same as that of new briquets.

Condition C: Top briquets appear similar to those in condition B, and show signs of further disintegration, having lost original sharp fracture. Erosion more evident on all briquets on outside of the pile. Inside briquets still firm, retaining original characteristics.

Condition D: Top briquets so badly disintegrated that they crumble to pieces on handling. Briquets in center of pile show signs of disintegration; luster of surfaces gone; edges soft, and break easily in the hand. Fracture not so sharp as when newly made, but briquets firm, and handled without breaking.

Condition E: Entire pile disintegrated. In many cases the only briquets retaining their original shape are those protected from the weather. Briquets can not be handled safely, but crush easily in the hand.

ABSORPTION TESTS.

The object of the absorption tests was to determine (1) the rate of absorption of water by the briquets each day; (2) the time required for the absorption to become practically complete; and (3) the time at which the absorption actually ceases or the briquet disintegrates. The apparatus consisted of a hydrostatic balance with containing tank and four galvanized-iron pans 24 by 36 by 6 inches. The total number of samples were tested in two sets—briquetting tests 138 to 198 and 199 to 250.

Four Renfrow briquets or one English briquet were taken as a sample from each representative lot of briquets tested. These briquets had been stored under cover directly after being made, so they may be safely considered as air-dried samples. So far as possible briquets with perfect surfaces were used.

The method used in testing was as follows:

(*a*) The sample was weighed in air to the nearest gram, on the upper part of the hydrostatic balance.

(*b*) The sample was then weighed in water by being submerged on the lower shelf of the balance, the hour and minute of this immersion being noted.

(*c*) The sample was removed from the balance, placed in pans, and covered with one-half inch of water.

(*d*) Each succeeding day at the same time as the first immersion the operation noted in *b* was repeated.

(*e*) The gain in weight was noted each day by subtracting the observation for that day from the weight noted in *b*.

(*f*) This gain in weight was calculated to per cent of the original weight of the dry briquet, and so recorded each day.

The hydrostatic balance was brought to perfect adjustment twice a day to correct for variation in density of water due to variations in its temperature, which was recorded three times daily.

DENSITY.

The apparent specific gravity, being the weight in air divided by the loss of weight in water, was calculated from readings *a* and *b* of the absorption tests.

SPECIAL TESTS.

Water-gas machine test.—The object of this test was (1) to determine if the briquets could be used as fuel for the production of water gas; (2) to compare the results obtained with those from retort coke; (3) to observe the behavior of the briquets in the apparatus.

The briquets made in test 164† (see p. 75) were shipped to the Mullanphy street station of the Laclede Gas Company, of St. Louis, Mo., and tested in an 8½-foot water-gas machine of the Lowe type. This machine has a rated capacity of 1,000,000 cubic feet in twenty-four hours. This test was made under the direction of W. A. Baehr, chief engineer of the company, and the observations given below were made by Mr. Wright.

Data from water-gas machine test.

Length of blast	minutes	5
Length of run	do	6
Total number of cycles		42
Total number of runs made		213
Total briquets used	pounds	85,100
Total gas recorded by meter in 48 hours	cubic feet	1,959,000
Correction for relief holder	do	56,100
Total gas made in 48 hours	do	1,902,900
Average temperature of gas metered	° F.	73
Total gas made in 48 hours corrected to 60° F	cubic feet	1,854,000
Total oil used in 48 hours	gallons	7,710
Average pressure of air during blast	inches of water	22.5
Average steam pressure during runs	pounds	29.2
Briquets per 1,000 feet of gas as metered (corrected to 60° F.)	do	45.9
5-hour coke per 1,000 feet of gas as metered (corrected to 60° F.)	do	31.5
Oil per 1,000 feet gas as metered (corrected to 60° F.)	gallons	4.16
Average luminosity of gas made	candlepower	19.4
Average amount of gas made, with briquets	candle feet	4.65
Average amount of gas made, with 5-hour coke	do	5.60
Average heat value of gas made, with briquets	B. t. u.	624
Average heat value of gas made, with 5-hour coke	do	643
Average yield of gas as metered per run, with briquets	cubic feet	8,940
Average yield of gas as metered per run, with 5-hour coke	do	8,450
Average amount of oil per run	gallons	36.2

Cupola test.—The briquets made in test 247 (see p. 293) were sent to the Madison plant of the American Car and Foundry Company, of St. Louis, Mo., and were tested in a cupola under the direction of Mr. Ireland, of the coking section. The object of this test was to determine if the coke breeze when briquetted could be made to replace or be used in connection with coke in foundry practice. It was hoped that, by the addition of lime to the pitch as a binder, the briquets would be able to support the weight above until they became thoroughly coked through, the lime being available also as a flux.

Coke was used during the first charges and 150 pounds of briquets were used on each of the last five charges, although 100 pounds of fuel is the regular practice at the foundry. The briquets were considerably broken up during the charging of the iron, and finally, as they got down well into the cupola, they broke down entirely, letting the iron down below the melting zone. After dropping the bottom, about 1,500 pounds of unmelted iron was found in the cupola.

COALS TESTED.

In this report are included 134[a] briquetting tests on 53 coals from 16 domestic States and 1 Territory and one sample from Argentina, as follows:

Briquetting tests made, by States, etc.

Coal.	Number of tests.	Coal.	Number of tests.	Coal.	Number of tests.
Alabama:		Indiana—Continued.		Tennessee—Continued.	
No. 2 B	1	No. 19	1	No. 4 (with Miscellaneous No. 5)	2
No. 4	1	No. 20	1	No. 7 B	1
Argentina No. 1	1	Indian Territory:		Nos. 9 B and 9 C mixed	1
Arkansas:		No. 2 B	12	No. 10	1
No. 7 B	1	No. 2 C	4	Texas No. 4	1
No. 13	3	No. 9	1	Utah:	
Illinois:		Kansas No. 2 B	7	No. 1 (with Rhode Island No. 1)	1
No. 7 E	1	Maryland No. 2	4	No. 2	1
No. 9 C	4	Missouri No. 10	5	No. 2 (with Rhode Island No. 1)	1
No. 12 B	3	*Pennsylvania:*		Virginia No. 5 B	2
No. 20 (with Kentucky No. 2 B)	2	No. 15	1	Washington No. 2	1
No. 21	1	No. 15 (with Rhode Island No. 1)	1	Wyoming No. 6	1
No. 23 B	1	No. 16	3	Miscellaneous:	
No. 28 A	6	No. 18	9	No. 5	1
No. 28 B	5	No. 18 (with Miscellaneous No. 9)	4	No. 9	2
No. 29 A	2	No. 18 (with Rhode Island No. 1)	1		134
No. 29 B	1	No. 19	3		
No. 30	3	No. 20	7		
No. 31	4	No. 22	3		
No. 33	4	Tennessee:			
Indiana:		No. 1	1		
No. 1 B	1	No. 4	1		
No. 5 B	2				
No. 6 B	2				

The detailed results of the briquetting tests may be found by referring to the index table (pp. 14–19).

[a] This number does not include 14 tests conducted on coals received during 1905, which are withheld for future publication.

RESULTS OF TESTS, BY STATES.

The following are the detailed results of tests made on the various samples of coals received from January 1, 1906, to June 30, 1907, arranged alphabetically according to States, and showing in definite order (see index table, p. 14), under the head of each fuel, all the tests made on the different samples of that fuel.

ALABAMA.

ALABAMA NO. 2.[a]

Bituminous coal from Carbon Hill, Walker County, on the Frisco System, was designated Alabama No. 2 B. The coal as worked at a depth of 30 feet at this place averages 4 feet 6 inches in thickness.

One sample of run-of-mine coal was shipped under the supervision of J. S. Burrows to the testing plant, and was used in making steaming tests 382, 383, and 410 (on briquets); washing test 163; coking test 142 (washed coal); cupola tests 107 and 131; and briquetting test 131.

Two mine samples were taken for chemical analysis. Sample 3011 was taken 3,500 feet northeast of slope, where the coal measured 4 feet 5 inches in thickness. Sample 3012 was taken 3,500 feet north of slope, where the coal measured 4 feet 6 inches in thickness.

CHEMICAL ANALYSES.

Alabama No. 2 B.

	Mine samples.		Car sample.	Steaming tests.[b]		
				382.	383.	410.
Laboratory No.	3011	3012	[c]3211			
Air-drying loss	2.70	2.40	1.70			
Proximate:						
Moisture	4.71	4.51	3.95	3.80	3.95	3.43
Volatile matter	31.80	31.81	30.70	32.09	30.70	32.74
Fixed carbon	53.32	54.76	50.76	50.47	50.76	51.34
Ash	10.17	8.92	14.59	13.64	14.59	12.49
Sulphur	1.33	1.48	1.12	1.19	1.12	1.24
Ultimate:						
Hydrogen			4.57	4.35	4.30	4.77
Carbon			66.21	69.71	68.94	72.17
Nitrogen			1.49	1.57	1.55	1.58
Oxygen			12.02	8.95	8.85	7.27
Ash				14.18	15.19	12.93
Sulphur				1.24	1.17	1.28
Calorific value (as received):						
Determined, calories	6,998		6,547			
Determined, B. t. u.	12,596		11,785			
Calculated from ultimate analysis, calories			6,433			
Calculated from ultimate analysis, B. t. u.			11,579			

[a] For tests of coal from this mine made during 1904, see Bull. U. S. Geol. Survey No. 261, 1905, pp. 32, 80, 88, 122; Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 38, 197, 337, 1017, 1328.
[b] Proximate analysis of coal as fired; ultimate analysis of dry coal figured from car sample.
[c] Sample taken from steaming test 383.

STEAMING TESTS.

Alabama No. 2 B (run of mine).

	Test 382.	Test 383.	Test 410.
Size as used:			
Over 1 inch.....per cent..	65.4	48.3	
½ inch to 1 inch.....do....	19.4	26.7	
¼ inch to ½ inch.....do....	6.5	12.1	See p. 49.
Under ¼ inch.....do....	8.7	12.9	
Duration of test.....hours..	10.0	10.03	9.98
Heating value of fuel.....B. t. u. per pound dry fuel..	12,411	12,269	12,856
Force of draft:			
Under stack damper.....inch water..	0.69	0.64	0.61
Above fire.....do....	.14	.12	.15
Furnace temperature.....°F..	2,280	2,020	2,215
Dry fuel used per square foot of grate surface per hour.....pounds..	23.53	17.26	18.13
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.87	2.83	3.26
Percentage of rated horsepower of boiler developed.....	108.6	79.2	91.4
Water apparently evaporated per pound of fuel as fired.....pounds..	6.68	6.64	7.5
Water evaporated from and at 212° F.:			
Per pound of fuel as fired.....do....	7.93	7.88	8.69
Per pound of dry fuel.....do....	8.24	8.20	9.00
Per pound of combustible.....do....	9.80	9.92	10.24
Efficiency of boiler, including grate.....per cent..	64.12	64.54	67.60
Fuel as fired:			
Per indicated horsepower hour.....pounds..	3.57	3.59	3.25
Per electrical horsepower hour.....do....	4.40	4.43	4.02
Dry fuel:			
Per indicated horsepower hour.....do....	3.43	3.45	3.14
Per electrical horsepower hour.....do....	4.24	4.26	.88

Remarks.—Test 410 on briquets from test 131; Renfrow briquets during the first half and English briquets during the last half of the test. No difference was noted in the action of the two kinds of briquets while burning, both burning with a long flame without smoke, coking and holding together well. The Renfrow briquets as fired were badly broken up. No clinker; ash of gray color and medium weight.

WASHING AND COKING TESTS.

Alabama No. 2 B (run of mine).

Washing test 163.—Size as used, crushed to 2 inches; jig used, Stewart. Raw coal, 15,860 pounds; washed, 13,700 pounds; refuse, 2,160 pounds.

Coking test 142.—Size as used, washed, finely crushed. Duration of test, 51 hours. Coal charged, 10,530 pounds. Coke produced, 6,197 pounds; 58.85 per cent. Breeze produced, 684 pounds; 6.50 per cent. Total yield, 65.35 pounds. Poor coke, soft and dense.

Analyses.

	Washing test 163.		Coking test 142.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	3.95	6.29	6.26	3.04
Volatile matter	30.70	.....	31.99	1.06
Fixed carbon	50.76	.....	52.66	82.15
Ash	14.59	9.39	9.09	13.75
Sulphur	1.12	1.22	1.36	1.16

Cupola tests of coke made from Alabama No. 2 B coal (washed).

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Phosphorus.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
		Per ct.			*Per ct.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
107	142	0.0700	1.88	7	99.9	Coke	200	58	58	57	57	430
						Pig iron	600	413	413	412	412	2,250
						Scrap	200	138	138	137	137	750
131	142	.0700	1.88	7	99.9	Coke	200	58	58	57	57	430
						Pig iron	600	413	413	412	412	2,250
						Scrap	200	138	138	137	137	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
107	1.59 p. m.	7	5	2,257	322	2,579	31	4,991	6.56	6.9	214	37
131	10.42 a. m.	7	7	1,852	365	2,217	29	4,587	5.80	12.33	413	48

LADLE RECORD.

Ladle No.	Test 107. Pounds.	Test 107. Time (p. m.).	Test 131. Pounds.	Test 131. Time (a. m.).	Ladle No.	Test 107. Pounds.	Test 107. Time (p. m.).	Test 131. Pounds.	Test 131. Time (a. m.).
1	69	2.11	33	10.51	15	75	2.26	90	11.11
2	69	2.11½	79	10.53	16	79	2.26½	62	11.11½
3	89	2.16	77	10.56	17	81	2.27	102	11.12
4	98	2.16½	30	10.57	18	89	2.28	94	11.13
5	82	2.19	74	10.58½	19	69	2.29	60	11.13½
6	101	2.19½	73	10.59	20	85	2.30	86	11.14
7	70	2.20	68	11.03	21	102	2.30½	20	11.14½
8	81	2.22	72	11.04	22	79	2.31	86	11.15
9	83	2.22½	76	11.04½	23	69	2.31½	53	11.15½
10	89	2.23	46	11.05	24	83	2.33	86	11.16
11	87	2.23½	71	11.07	25	103	2.33½	82	11.17
12	95	2.24	60	11.07½	26	52	2.34	131	11.18
13	82	2.25	94	11.08	27	97	2.35	.....	.....
14	99	2.25½	47	11.08½					

Remarks.—Test 107: Iron very hot and fluid.

BRIQUETTING TEST.

Alabama No. 2 B (run of mine).

Test 131.—Size as used: Over ¼ inch, 2.8 per cent; $\frac{1}{10}$ inch to ¼ inch, 11.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 21.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 23.4 per cent, through $\frac{1}{40}$ inch, 41 per cent. Kind of binder, water-gas pitch; laboratory No. 3410 (see p. 40); weight of fuel briquetted, 14,000 pounds. B. t. u. per pound of coal as received, 11,939; per pound of briquets as fired, 12,115; per pound of binder, 16,478. For analyses of briquets see page 47 (steaming test 410).

English briquets made at 175° F., average weight 3.31 pounds, with 5 and 6 per cent binder, proved to be good briquets; fracture clean; edges and surfaces firmer with 6 per cent than with 5 per cent binder. In the drop test with 5 per cent binder the

1-inch screen held 91.5 per cent and passed 8.5 per cent. In the weathering test all were exposed 197 days; condition, B.

Renfrow briquets made at 149° F., average weight 0.47 pound, with 6 per cent pitch, showed evidences of shortage in binder; surfaces crumbled and fracture not clean. Seven per cent binder made hard, firm surfaces; broke without crumbling, and surfaces and edges were firm. In the weathering test the 6 per cent binder briquets were exposed 201 days and those with 7 per cent 200 days; condition of both, B.

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 131.
Laboratory No	3410	3211	.....
Air-drying loss, per cent	.....	1.70	0.80
Extracted by CS_2:			
Air-dried, do	.....	1.37	4.79
As received, do	79.98	1.35	4.75
Pitch in briquets, as received, do	.....	.....	4.32

ALABAMA NO. 3.

Bituminous coal from Garnsey, Bibb County, on the Louisville and Nashville Railroad, was designated Alabama No. 3. The coal as worked at a depth of 700 feet at this place averages 5 feet 6 inches in thickness.

Run-of-mine coal shipped under the supervision of John W. Groves was used in making steaming tests 390 and 394; washing test 161; coking tests 138 (raw) and 139 (washed); and cupola tests 101, 108, and 132.

Two mine samples were taken for chemical analysis. Sample 3018 was taken 2,700 feet south of the slope, where the coal measured 5 feet in thickness. Sample 3019 was taken 2,500 feet southwest of the slope, where the coal measured 5 feet 8 inches in thickness.

CHEMICAL ANALYSES.

Alabama No. 3.

	Mine samples.		Car sample.	Steaming tests.[a]	
				390.	394.
Laboratory No	3018	3019	3255	.....	.....
Air-drying loss	1.60	1.90	1.20	.....	.....
Proximate:					
Moisture	3.03	3.25	2.72	2.93	2.88
Volatile matter	30.94	30.43	29.46	28.03	29.58
Fixed carbon	55.31	54.16	53.46	48.25	49.12
Ash	10.72	12.16	14.36	20.79	18.42
Sulphur	.49	.53	.55	.55	.58
Ultimate:					
Hydrogen	.....	.....	4.55	4.03	4.15
Carbon	.....	.....	69.99	66.28	68.34
Nitrogen	.....	.....	1.14	1.08	1.11
Oxygen	.....	.....	9.41	6.62	6.83
Ash	.....	.....	.....	21.42	18.97
Sulphur	.....	.....	.....	.57	.60
Calorific value (as received):					
Determined, calories	7,241	.....	6,923	.....	.....
Determined, B. t. u.	13,034	.....	12,461	.....	.....
Calculated from ultimate analysis, calories	.....	.....	6,829	.....	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	12,292	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Alabama No. 3 (run of mine).

	Test 390.	Test 394.
Size as used:		
Over 1 inch ..... per cent..	19.9	13.7
½ inch to 1 inch ..... do....	18.6	19.5
¼ inch to ½ inch ..... do....	19.4	19.9
Under ¼ inch ..... do....	42.1	46.9
Duration of test ..... hours..	10.0	10.0
Heating value of coal ..... B. t. u. per pound dry coal..	11,806	12,175
Force of draft:		
Under stack damper ..... inch water..	0.55	0.60
Above fire ..... do....	.18	.21
Furnace temperature ..... °F....	2,040	2,160
Dry coal used per square foot of grate surface per hour ..... pounds..	20.69	21.04
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.31	3.38
Percentage of rated horsepower of boiler developed	92.7	94.8
Water apparently evaporated per pound of coal as fired ..... pounds..	6.69	6.70
Water evaporated from and at 212°F:		
Per pound of coal as fired ..... do....	7.77	7.82
Per pound of dry coal ..... do....	8.00	8.05
Per pound of combustible ..... do....	10.49	10.21
Efficiency of boiler, including grate ..... per cent..	65.44	63.85
Coal as fired:		
Per indicated horsepower hour ..... pounds..	3.64	3.62
Per electrical horsepower hour ..... do....	4.49	4.47
Dry coal:		
Per indicated horsepower hour ..... do....	3.54	3.51
Per electrical horsepower ..... do....	4.36	4.34

WASHING AND COKING TESTS.

Alabama No. 3 (run of mine).

Washing test 161.—Size as used, crushed to 2 inches. Jig used, Stewart. Raw coal, 18,000 pounds; washed, 16,500 pounds; refuse, 1,500 pounds.

Coking tests.

	Test 138 (raw).	Test 139 (washed).
Size as used	f. c.	f. c.
Duration of test ..... hours..	54	44
Coal charged ..... pounds..	12,180	11,660
Coke produced ..... do....	7,802	7,072
Coke produced ..... per cent..	64.06	60.65
Breeze produced ..... pounds...	489	258
Breeze produced ..... per cent..	4.01	2.21
Total yield ..... do....	68.07	62.86

Remarks.—Test 138: Good, hard, heavy coke with exception of ¾-inch black butts, which should be easily removed. Ash should be very much lowered by washing. Test 139: Good, strong, hard, heavy coke; ash reduced, and much better coke than from raw charge; black butts removed.

Analyses.

	Washing test 161.		Coking test 138.		Coking test 139.	
	Raw coal (mine sample).	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	3.03	5.82	2.77	2.03	6.36	0.99
Volatile matter	30.94	.....	28.99	1.80	30.54	1.06
Fixed carbon	55.31	.....	53.14	74.89	53.10	83.51
Ash	10.71	10.01	15.10	21.28	10.00	14.44
Sulphur	.49	.58	.62	.60	.62	.58

Cupola tests of coke made from Alabama No. 3 coal.

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Phosphorus.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
		Per ct.			*Per ct.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
132	138 (raw)	0.0057	1.91	7	97.22	Coke	210	55	55	55	55	430
						Pig iron	630	405	405	405	405	2,250
						Scrap	210	135	135	135	135	750
101	139(w.)	.0008	1.99	7	99.9	Coke	210	55	55	55	55	430
						Pig iron	630	405	405	405	405	2,250
						Scrap	210	135	135	135	135	750
108	139(w.)	.0008	1.99	7	94.44	Coke	210	55	55	55	55	430
						Pig iron	630	405	405	405	405	2,250
						Scrap	210	135	135	135	135	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
132	2.49 p. m.	7	12	740	214	954	26	2,201	3.21	4.46	1,911	132
101	11.17 a. m.	7	10	1,695	305	2,000	35	3,429	5.63	6.43	807	75
108	3.39 p. m.	7	5	1,822	213	2,035	33	3,700	6.15	6.36	774	99

LADLE RECORD.

Ladle No.	Test 132. Lbs.	Test 132. Time (p.m.).	Test 101. Lbs.	Test 101. Time (a.m.).	Test 108. Lbs.	Test 108. Time (p.m.).	Ladle No.	Test 132. Lbs.	Test 132. Time (p.m.).	Test 101. Lbs.	Test 101. Time (a.m.).	Test 108. Lbs.	Test 108. Time (p.m.).
1	92	3.10	77	11.32	103	3.55	12	64	3.27	74	11.50	79	4.07
2	100	3.10½	91	11.36	119	3.55½	13	.....	.....	85	11.53	101	4.07½
3	61	3.11	97	11.36½	51	3.56	14	.....	.....	86	11.53½	102	4.08
4	77	3.13	72	11.43	63	4.00	15	.....	.....	67	11.54	58	4.08½
5	77	3.13½	72	11.43½	116	4.00½	16	.....	.....	78	11.56	61	4.12
6	70	3.16	70	11.44	102	4.01	17	.....	.....	95	11.56½	85	4.12½
7	34	3.16½	62	11.47	110	4.01½	18	.....	.....	71	11.57	95	4.13
8	65	3.18	76	11.47½	86	4.03½	19	.....	.....	73	11.59	81	4.16
9	34	3.19	73	11.48	107	4.04	20	.....	.....	97	11.59½	100	4.17
10	64	3.23	91	11.49	91	4.04½	21	.....	.....	65	12.00	.....	.....
11	2	3.23½	74	11.49½	106	4.05	22	.....	.....	49	12.02	.....	.....

Remarks.—Test 101: Iron hot. Test 108: Iron hot; slag filled up tuyeres after twentieth ladle and bottom had to be dropped.

ALABAMA NO. 4.

Bituminous coal from Cane Creek, 3 miles north of Belle Ellen, Bibb County, on the Louisville and Nashville Railroad, was designated Alabama No. 4. The coal as worked at a depth of 150 feet at this place averages 2 feet 11 inches in thickness.

The sample consisted of run-of-mine coal, inspected by John W. Groves, and was used in making steaming tests 375, 376, 377, 378, and 413 (on briquets); producer-gas test 109; washing test 159;

coking tests 131 (raw) and 136 (washed); cupola tests 103, 109, 124 and 133; and briquetting test 123.

Two mine samples were taken for chemical analysis. Sample 3034 was taken 900 feet northeast of the slope, where the coal measured 2 feet 10 inches in thickness. Sample 3035 was taken 1,500 feet northeast of the slope, where the coal measured 2 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Alabama No. 4.

	Mine samples.		Car sample.	Steaming tests.[a]				
				375.	376.	377.	378.	413.
Laboratory No.	3034	3035	3102					
Air-drying loss	2.60	2.40	5.50					
Proximate:								
Moisture	3.67	3.60	6.43	4.04	4.84	5.69	5.27	2.46
Volatile matter	33.55	34.08	28.56	30.27	28.17	26.94	28.72	32.27
Fixed carbon	59.64	59.86	52.09	55.26	52.70	49.48	52.78	56.55
Ash	3.14	2.46	12.92	10.48	14.29	17.89	13.23	8.72
Sulphur	1.22	1.50	1.08	1.29	1.22	1.05		1.18
Ultimate:								
Hydrogen			5.23	4.98	4.75	4.54	4.83	4.72
Carbon			69.07	76.16	72.67	69.36	73.90	76.96
Nitrogen			1.18	1.30	1.24	1.19	1.27	1.32
Oxygen			10.52	5.30	5.04	4.83	5.13	6.85
Ash				10.92	15.02	18.97	13.97	8.94
Sulphur				1.34	1.28	1.11	.90	1.21
Calorific value (as received):								
Determined, calories	7,998		6,886					
Determined, B. t. u.	14,396		12,395					
Calculated from ultimate analysis, calories			6,952					
Calculated from ultimate analysis, B. t. u.			12,514					

STEAMING TESTS.

Alabama No. 4 (run of mine).

	Test 375.	Test 376.	Test 377.	Test 378.	Test 413.
Size as used:					
Over 1 inch, per cent.	17.1	18.1	7.1	17.1	See p. 56.
½ inch to 1 inch, do	20.2	18.0	12.4	19.5	
¼ inch to ½ inch, do	22.1	17.3	16.8	25.2	
Under ¼ inch, do	40.6	46.6	63.7	38.2	
Duration of test, hours	10.17	9.77	10.00	8.03	9.07
Heating value of fuel, B. t. u. per pound dry fuel	13,671	13,041	12,447	13,244	13,932
Force of draft:					
Under stack damper, inch water	0.64	0.55	0.63	0.60	0.66
Above fire, do	.20	.19	.22	.18	.10
Furnace temperature, °F	2,461	(b)			2,430
Dry fuel used per square foot of grate surface per hour, pounds	20.94	17.39	18.45	15.91	21.11
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.81	2.97	3.10	2.76	3.90
Percentage of rated horsepower of boiler developed	106.9	83.2	87.0	77.4	109.5
Water apparently evaporated per pound of fuel as fired, pounds	7.37	6.88	6.73	7.04	7.75
Water evaporated from and at 212° F:					
Per pound of fuel as fired, do	8.75	8.14	7.95	8.24	9.02
Per pound of dry fuel, do	9.12	8.55	8.43	8.69	9.25
Per pound of combustible, do	10.55	10.46	10.81	10.46	10.29
Efficiency of boiler, including grate, per cent	64.42	63.31	65.40	63.36	64.12
Fuel as fired:					
Per indicated horsepower hour, pounds	3.23	3.47	3.56	3.43	3.14
Per electrical horsepower hour, do	3.99	4.29	4.39	4.24	3.87
Dry fuel:					
Per indicated horsepower hour, do	3.10	3.31	3.35	3.25	3.06
Per electrical horsepower hour, do	3.83	4.08	4.14	4.02	3.77

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] One-half of observations too low to be read with Wanner pyrometer.

Remarks.—Test 413 on briquets: The briquets burned freely, with long flame, coked well, and held together well until entirely consumed. The English briquets were nearly all fired whole. Clinker was dark and heavy; plastic when hot, and brittle when cold; contained a large amount of slag, but did not stick to the grate. Small quantity of ash.

PRODUCER-GAS TEST.

Alabama No. 4 (run of mine).

Test 109.—Duration of test, 24 hours; average electrical horsepower, 195.0; average B. t. u. per cubic foot of gas, 152.0; total coal fired, 5,850 pounds.

	As fired.	Dry.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.33	1.29	1.12
Developed at switch board	1.25	1.21	1.06
Per brake horsepower:			
Commercially available	1.13	1.09	.95
Developed at engine	1.06	1.03	.90
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.45	1.40	1.22
Developed at switch board	1.36	1.32	1.15
Per brake horsepower:			
Commercially available	1.23	1.19	1.04
Developed at engine	1.16	1.12	.97

Analyses.

Coal.		*Gas by volume.*	
Moisture	3.05	Carbon dioxide (CO_2)	10.1
Volatile matter	29.53	Carbon monoxide (CO)	17.0
Fixed carbon	54.78	Hydrogen (H_2)	14.5
Ash	12.64	Methane (CH_4)	1.9
Sulphur	1.15	Nitrogen (N_2)	56.1
		Ethylene (C_2H_4)	.4

WASHING AND COKING TESTS.

Alabama No. 4 (run of mine)

Washing test 159.—Size as used, crushed to 2 inches; jig used, Stewart. Raw coal, 17,000 pounds; washed, 14,470 pounds; refuse, 2,530 pounds.

Coking tests.

		Test 131 (raw).	Test 136 (washed).
Size as used		f. c.	f. c.
Duration of test	hours	47	49
Coal charged	pounds	12,000	12,000
Coke produced	do	7,706	6,809
	per cent	64.22	56.74
Breeze produced	pounds	281	239
	per cent	2.34	1.99
Total yield	do	66.56	58.73

Remarks.—Test 131: Good, strong coke, light-gray and silvery color; ash and sulphur high; might be improved by washing. (Compare test 136.) Test 136: Good, strong coke; light-gray and silvery color; breakage; good uniform size; ash and sulphur reduced very materially by washing.

Analyses.

	Washing test 159.		Coking test 131.		Coking test 136.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	6.43	6.82	4.17	0.29	7.28	0.35
Volatile matter	28.56	.....	30.37	.84	30.46	.42
Fixed carbon	52.09	.....	54.50	83.21	58.38	92.99
Ash	12.92	3.81	10.96	15.66	3.88	6.24
Sulphur	1.08	1.03	1.18	1.08	1.00	.87

Cupola tests of coke made from Alabama No. 4 coal.

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Phosphorus.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
		Per ct.			*Per ct.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
103	131	0.0126	1.95	7	98.61	Coke	200	58	58	57	57	430
						Pig iron	600	413	413	412	412	2,250
						Scrap	200	138	138	137	137	750
124	131	.0126	1.95	7	80.55	Coke	220	53	53	52	52	430
						Pig iron	660	398	398	397	397	2,250
						Scrap	220	133	133	132	132	750
109	136(w.)	.008	1.95	7	99.9	Coke	190	60	60	60	60	430
						Pig iron	570	420	420	420	420	2,250
						Scrap	190	140	140	140	140	750
133	136(w.)	.008	1.95	7	98.61	Coke	200	58	58	57	57	430
						Pig iron	600	413	413	412	412	2,250
						Scrap	200	138	138	137	137	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
103	8.19 a. m.	7	11	1,451	217	1,668	33	3,033	5.49	4.90	1,185	126
124	10.04 a. m.	7	10	1,368	542	1,910	27	4,244	5.76	10.66	770	99
109	10.30 a. m.	7	7	2,328	153	2,481	27	5,513	6.93	6.16	334	72
133	10.53 a. m.	7	8	1,952	178	2,130	32	4,260	6.96	5.76	697	124

LADLE RECORD.

Ladle No.	Test 103. Pounds.	Test 103. Time (a. m.).	Test 124. Pounds.	Test 124. Time (a. m.).	Test 109. Pounds.	Test 109. Time (a. m.).	Test 133. Pounds.	Test 133. Time (a. m.).
1	66	8.35	91	10.19	54	10.41	51	11.07
2	95	8.38	34	10.19½	112	10.45	84	11.10
3	75	8.41	90	10.26	125	10.45½	94	11.11
4	36	8.42	76	10.26½	102	10.46	69	11.13
5	96	8.43	83	10.27	112	10.47	82	11.15
6	61	8.45	69	10.30	110	10.47½	105	11.15½
7	101	8.45½	72	10.31	69	10.48	80	11.16
8	70	8.51	92	10.32	108	10.51½	72	11.18½
9	88	8.51½	57	10.33	114	10.52	116	11.19
10	99	8.52	66	10.33½	92	10.52½	92	11.19½
11	94	8.56	90	10.34	113	10.53	83	11.20
12	97	8.56½	64	10.34½	104	10.55	107	11.22
13	90	8.57	53	10.35	105	10.55½	102	11.22½
14	104	8.59	80	10.37	108	10.56	80	11.23
15	96	8.59½	53	10.37½	100	10.56½	106	11.23½
16	88	9.00	99	10.38	97	10.57	68	11.24
17	95	9.03	66	10.38½	118	10.57½	101	11.26
18	.....	.....	72	10.40	110	10.58	104	11.27
19	.....	.....	61	10.41	80	10.59	77	11.27½
20	.....	.....	.....	.....	110	11.02	84	11.28
21	.....	.....	.....	.....	96	11.03	52	11.29
22	.....	.....	.....	.....	80	11.03½	103	11.32
23	.....	.....	.....	.....	109	11.04	40	11.33

Remarks.—Test 103: Temperature of iron, medium. Test 124: Iron sluggish. Test 109: Iron very hot and fluid.

BRIQUETTING TEST.

Alabama No. 4 (run of mine).

Test 123.—Size as used: Over ¼ inch, 1.2 per cent; $\frac{1}{10}$ inch to ¼ inch, 4.5 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 14 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 23.5 per cent; through $\frac{1}{40}$ inch, 56.8 per cent. Kind of binder, water-gas pitch; laboratory No. 3410 (see p. 40). Weight of fuel briquetted, 15,200 pounds. B. t. u. per pound of coal as received, 12,395; per pound of briquets as fired, 13,590; per pound of binder, 16,478. For analyses of briquets see page 53 (steaming test 413).

English briquets made at 179.6° F., 3.37 pounds average weight, with 5.5 per cent binder, had edges that crumbled slightly, but surfaces were firm; fracture slightly crumbly. With 6, 6.5, and 7 per cent binder the outer surfaces were smooth and hard, fracture clean, and broken surfaces rough but very firm. In the drop test with 6 per cent binder the 1-inch screen held 83.3 per cent and passed 16.7 per cent. In the weathering test briquets of all binders were exposed 214 days; condition B.

Renfrow briquets made at 149° F., 0.43 pound average weight, with 6 and 6.5 per cent binder, were crumbly and broke easily; broken surfaces crumbly. With 7 and 7.5 per cent binder tough briquets resulted, with hard and smooth outer surfaces; broke with clean fracture. In the weathering test all binders were exposed 214 days; condition for the 7.5 per cent binder, B, for the others, C.

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 123.
Laboratory No.	3410	3103	.....
Air-drying loss.....per cent.	.....	5.50	0.90
Extracted by CS_2:			
Air-dried.....do....	.....	.46	4.90
As received.....do....	78.98	.43	4.86
Pitch in briquets, as received.....do....	.....	.....	5.57

ALABAMA NO. 5.

Bituminous coal from the Black Creek bed at Lehigh, Blount County, on the Louisville and Nashville Railroad, was designated Alabama No. 5. The coal, as worked from the outcrop of this place, averages 2 feet 8 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of run-of-mine coal and was used in steaming tests 478 and 480, washing test 195, and coking test 171.

Two mine samples were taken for chemical analysis. Sample 4090 was taken 2,000 feet south of the opening, where the coal measured 3 feet in thickness. Sample 4091 was taken 2,100 feet south of the opening, where the coal measured 2 feet 4½ inches in thickness.

CHEMICAL ANALYSES.

Alabama No. 5.

	Mine samples.		Car sample.	Steaming tests.[a]	
				478.	480.
Laboratory No.	4090	4091	4252	.....	.....
Air-drying loss	3.60	1.90	4.40	.....	.....
Proximate:					
Moisture	4.72	2.93	5.59	5.51	5.70
Volatile matter	28.69	29.06	25.05	24.15	23.85
Fixed carbon	62.45	65.28	53.28	50.44	52.74
Ash	4.14	2.73	16.08	19.90	17.71
Sulphur	.83	.65	1.40	1.90	1.47
Ultimate:					
Hydrogen	.....	.....	4.70	4.09	4.22
Carbon	.....	.....	66.58	66.58	68.94
Nitrogen	.....	.....	1.27	1.27	1.31
Oxygen	.....	.....	9.92	4.99	5.19
Ash	.....	.....	.....	21.06	18.18
Sulphur	.....	.....	.....	2.01	1.56
Calorific value determined (as received) calories	.....	81.63	66.16	.....	.....
Calorific value determined (as received) B. t. u.	.....	146.93	119.06	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Alabama No. 5 (run of mine).

	Test 478.	Test 480.
Size as used:		
Over 1 inch ..... per cent	4.8	4.1
½ inch to 1 inch ..... do	13.8	15.3
¼ inch to ½ inch ..... do	19.5	22.7
Under ¼ inch ..... do	61.9	57.9
Average diameter ..... inch	0.38	0.39
Duration of test ..... hours	9.93	9.57
Heating value of coal ..... B. t. u. per pound of dry coal	11,932	12,335
Force of draft:		
Under stack damper ..... inch water	0.89	0.86
Above fire ..... do	.19	.09
In ash pit (forced draft) ..... do	.....	.25
Furnace temperature, °F	2,561	.....
Dry coal used per square foot of grate surface per hour ..... pounds	19.01	22.86
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	2.94	3.73
Percentage of rated horsepower of boiler developed	82.6	104.6
Water apparently evaporated per pound of coal as fired ..... pounds	6.08	6.40
Water evaporated from and at 212° F.:		
Per pound of coal as fired ..... do	7.33	7.70
Per pound of dry coal ..... do	7.76	8.17
Per pound of combustible ..... do	10.34	10.65
Efficiency of boiler, including grate ..... per cent	62.80	63.96
Coal as fired:		
Per indicated horsepower hour ..... pounds	3.85	3.67
Per electrical horsepower hour ..... do	4.76	4.53
Dry coal:		
Per indicated horsepower hour ..... do	3.64	3.46
Per electrical horsepower hour ..... do	4.50	4.27

WASHING TEST.

Alabama No. 5 (run of mine.)

Test 195 (preliminary float and sink tests on raw coal[a]).

Float and sink test No.	Size used.	Specific gravity of solution used.	Float (per cent).	Sink (per cent).	Float coal analysis.			
					Ash.		Sulphur.	
					Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
1	¾ inch	1.35	81	19	2.18	86	0.81	42
2	do	1.40	85	15	2.63	84	.98	30
3	do	1.45	87	13	2.66	84	1.05	25
4	do	1.52	87	13	3.19	80	1.13	19

[a] Not enough coal for other tests.

COKING TEST.

Alabama No. 5 (run of mine).

Test 171.—Size as used, raw, finely crushed. Duration of test, 42 hours; coal charged, 12,110 pounds; coke produced, 7,950 pounds, 65.65 per cent; breeze produced, 390 pounds, 3.22 per cent; total yield, 68.87 per cent. Good coke, light gray and silvery. Ash high; washing would improve, reducing both ash and sulphur.

Analyses.

	Coal.	Coke.
Moisture	3.98	0.59
Volatile matter	26.55	.89
Fixed carbon	56.92	81.10
Ash	12.55	17.42
Sulphur	1.44	1.16

ALABAMA NO. 6.

Bituminous coal from the Pratt bed at Dolomite, Jefferson County, was designated Alabama No. 6. This coal, as worked from the outcrop at this place, averages 4 feet 8 inches in thickness.

This sample consisted of run-of-mine coal shipped under the supervison of K. M. Way, and was used in steaming test 484, producer-gas test 155, washing test 192, and coking tests 172 and 174 (washed).

Two mine samples were taken for chemical analysis. Sample 4292 was taken 2 miles southeast of the opening, where the coal measured 4 feet 8¼ inches in thickness. Sample 4293 was taken 2 miles east of the opening, where the coal measured 4 feet 8¼ inches in thickness.

CHEMICAL ANALYSES.

Alabama No. 6.

	Mine samples.		Car samples.		Steaming test 484.[a]
Laboratory No.	4292	4293	4338	4353	.....
Air-drying loss	2.30	2.20	2.40	2.80	.....
Proximate:					
Moisture	3.23	2.81	3.23	3.56	2.86
Volatile matter	26.97	26.52	26.16	26.24	25.80
Fixed carbon	65.97	67.16	63.90	63.25	63.98
Ash	3.83	3.51	6.71	6.95	7.36
Sulphur	.57	.59	.61	.58	.57
Ultimate:					
Hydrogen	.....	.....	4.99	.....	4.76
Carbon	.....	.....	78.33	.....	80.42
Nitrogen	.....	.....	1.42	.....	1.46
Oxygen	.....	.....	7.94	.....	5.19
Ash	.....	.....	.....	.....	7.58
Sulphur	.....	.....	.....	.....	.59
Calorific value determined (as received) calories	.....	81.35	78.19	.....	.....
Calorific value determined (as received) B. t. u.	.....	146.43	140.74	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Alabama No. 6 (run of mine).

	Test 484.
Size as used:	
Over 1 inch.....per cent..	23.9
½ inch to 1 inch.....do....	23.3
¼ inch to ½ inch.....do....	17.6
Under ¼ inch.....do....	35.2
Average diameter.....inch..	.76
Duration of test.....hours..	9.58
Heating value of coal.....B. t. u. per pound dry coal..	14,447
Force of draft:	
Under stack damper.....inch water..	0.82
Above fire.....do....	.17
Dry coal used per square foot of grate surface per hour.....pounds..	20.22
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	4.00
Percentage of rated horsepower of boiler developed.....	112.2
Water apparently evaporated per pound of coal as fired.....pounds..	7.96
Water evaporated from and at 212° F.:	
Per pound of coal as fired.....do....	9.64
Per pound of dry coal.....do....	9.92
Per pound of combustible.....do....	10.99
Efficiency of boiler, including grate.....per cent..	66.30
Coal as fired:	
Per indicated horsepower hour.....pounds..	2.93
Per electrical horsepower hour.....do....	3.62
Dry coal:	
Per indicated horsepower hour.....do....	2.85
Per electrical horsepower hour.....do....	3.52

PRODUCER-GAS TEST.

Alabama No. 6 (run of mine).

Test 155.—Duration of test, 50 hours. Average electrical horsepower, 198.6, average B. t. u. per cubic foot of gas, 143.7, total coal fired, 9,000 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	0.94	0.91	0.85
Developed at switchboard	.91	.89	.82
Per brake horsepower:			
Commercially available	.79	.78	.72
Developed at engine	.77	.75	.70
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.02	1.00	.93
Developed at switchboard	.99	.97	.90
Per brake horsepower:			
Commercially available	.87	.85	.79
Developed at engine	.84	.82	.76

Analyses.

Coal.		*Gas by volume.*	
Moisture	2.44	Carbon dioxide (CO_2)	9.6
Volatile matter	25.96	Carbon monoxide (CO)	19.5
Fixed carbon	64.70	Hydrogen (H_2)	14.9
Ash	6.90	Methane (CH_4)	1.7
Sulphur	.59	Nitrogen (N_2)	54.2
		Ethylene (C_2H_4)	.1

WASHING AND COKING TESTS.

Alabama No. 6 (run of mine).

Washing test 192.—Duration of test, 1¼ hours. Size as used, through 1-inch screen. Jig used, special; speed, 70 r. p. m.; stroke, 2½ inches. Raw coal, 12 tons; washed coal, 10.75 tons, 90 per cent; refuse, 1.25 tons, 10 per cent.

Analyses.

Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur.
			Per cent.	Per cent reduction.	Per cent
Raw coal, car sample	4353	3.39	6.84	.....	0.59
Washed coal, test 192	4419	6.69	4.76	30	.59
Refuse	.....	8.21	34.92	.....	2.20

Float and sink tests.

No. of test.	Size used (inch).	Specific gravity of solution used.	Percentage of float.		Sink (per cent).	Analyses.			
			To refuse.	To total sample.		Ash.		Sulphur.	
						Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
On raw coal (preliminary):									
1	¾	1.36	.....	87	13	2.81	59	0.54	8.5
2	¾	1.42	.....	90	10	3.51	49	.57	4.0
3	¾	1.48	.....	91	9	3.43	50	.53	10.0
4	¾	1.56	.....	94	6	3.75	45	.56	5.0
On refuse (float):[a]									
1	.....	1.35	18.40	1.91	.....	2.81	.....	.89	.....
2	.....	1.40	20.80	2.16	.....	3.48	.....	1.01	.....
3	.....	1.45	20.80	2.16	.....	4.06	.....	1.17	.....
4	.....	1.52	22.30	2.32	.....	5.09	.....	1.06	.....

[a] Figures indicate that finer crushing is advantageous. Loss of "good coal" in the refuse will not exceed 1 per cent. By "good coal" is meant all coal of a quality equal to or better than that of the washed coal. It will be noted that in the washing test the sulphur shows the same percentage in the washed coal that it did in the raw coal. This is due to the fact that the reduction of the ash is so much greater than the reduction of the sulphur that the resulting percentage of the sulphur to the washed coal is the same as that of the original sulphur to the raw coal. By the formula $Y=\frac{c-M}{c}$ it is found that 10 per cent of the sulphur in the raw coal was removed in washing.

Coking tests.

	Test 172 (raw).	Test 174 (w.).
Size as used	f. c.	f. c.
Duration of test, hours	40	50
Coal charged, pounds	12,100	11,880
Coke produced, do	8,350	7,800
Coke produced, per cent	69.01	65.66
Breeze produced, pounds	316	221
Breeze produced, per cent	2.61	1.86
Total yield, do	71.62	67.52

Remarks.—Test 172: Good heavy coke, light-gray and silvery color; metallic ring; cell structure good; breakage good, uniform-sized pieces. Test 174: Good heavy coke, light-gray and silvery color; cell structure rather small; breakage good, uniform-sized pieces; coke better than from raw charge; improvement does not warrant washing, as ash and sulphur are both low.

Analyses.

	Washing test 192, car sample raw coal.	Coking test 172.		Coking test 174.	
		Coal.	Coke.	Coal.	Coke.
Moisture	3.39	3.28	0.46	6.73	0.63
Volatile matter	26.20	25.30	.35	24.84	.27
Fixed carbon	63.57	64.50	89.37	63.57	92.36
Ash	6.84	6.92	9.82	4.86	6.74
Sulphur	.59	.59	.59	.59	.60

ARGENTINA.

ARGENTINA NO. 1.

Coal received from the Province of Mendoza, Argentina, South America, was designated Argentina No. 1.

The coal was taken from two different parts of the mine, the depths being 290 and 110 to 140 feet, respectively, and was used in steaming tests 451, 458, and 485 (on briquets); washing tests 187 and 187a; and briquetting test 180.

CHEMICAL ANALYSES.

Argentina No. 1.

	Car samples.		Steaming tests.[a]		
			451.	458.	485.
Laboratory No	4060	4079			
Air-drying loss		3.00			
Proximate:					
Moisture	7.10	7.67	6.94	16.48	8.75
Volatile matter	19.37	18.39	16.87	17.96	21.45
Fixed carbon	30.97	31.09	26.03	34.23	33.75
Ash	42.56	42.85	50.16	31.33	36.05
Sulphur	.82	1.21	.60	.65	.80
Ultimate:					
Hydrogen		3.40	2.40	3.26	3.41
Carbon		36.55	34.42	46.73	47.51
Nitrogen		.95	.89	1.21	.92
Oxygen		15.04	7.74	10.51	7.77
Ash			53.91	37.51	39.51
Sulphur			.64	.78	.88
Calorific value (as received):					
Determined (calories)		3,511			
Determined (B. t. u.)		6,320			
Calculated from ultimate analysis (calories)		3,504			
Calculated from ultimate analysis (B. t. u.)		6,307			

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Argentina No. 1 (run of mine).

	Test 451.	Test 458 (w.).	Test 485 (w.).[a]
Size as used:			
Over 1 inch.....per cent..	20.5	4.1	
½ inch to 1 inch.....do....	18.8	10.9	
¼ inch to ½ inch.....do....	18.7	13.6	See p. 63.
Under ¼ inch.....do....	42.0	71.4	
Average diameter.....inch..	0.63	0.32	
Duration of test.....hours..	8.15	8.88	[b] 2.80
Heating value of fuel.....B. t. u. per pound of dry fuel..	5,933	8,298	8,235
Force of draft:			
Under stack damper.....inch water..	0.60	0.76	0.80
Above fire.....do....	.18	.11	.02
In ash pit (forced draft).....do....	.71	.53	.55
Furnace temperaure.....°F.		[c] 2,014	
Dry fuel used per square foot of grate surface per hour.....pounds..	24.32	21.58	31.34
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	1.22	1.89	2.65
Percentage of rated horsepower of boiler developed.....	34.2	52.9	74.3
Water apparently evaporated per pound of fuel as fired.....pounds..	1.96	3.04	3.20
Water evaporated from and at 212° F.:			
Per pound of fuel as fired.....do....	2.34	3.66	3.87
Per pound of dry fuel.....do....	2.51	4.38	4.24
Per pound of combustible.....do....	6.80	7.95	8.52
Efficiency of boiler, including grate.....per cent..	40.85	50.97	49.72
Fuel as fired:			
Per indicated horsepower hour.....pounds..	12.09	7.73	7.31
Per electrical horsepower hour.....do....	14.92	9.54	9.02
Dry fuel:			
Per indicated horsepower hour.....do....	11.27	6.46	6.67
Per electrical horsepower hour.....do....	13.91	7.97	8.23

[a] On Renfrow briquets, made in test 180, briquets burned slowly; did not crack open; gave low furnace temperature, and made 4 per cent black smoke. Ash formed on surface of briquets, and tended to form clinker, holding large amount of unconsumed fuel. These lumps were hard to break up. Ash and clinker were white and gray; 60 per cent clinker.

[b] The test was too short for reliable results.

[c] 25 per cent of the reading too low to be read by pyrometer.

WASHING TESTS.

Argentina No. 1 (run of mine).

Preliminary float and sink tests on raw coal.

Float and sink test No.	Size used (inch).	Specific gravity of solution used.	Float (per cent).	Sink (per cent).	Float coal analysis.			
					Ash.		Sulphur.	
					Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
1	1½ to 1¼	1.55	45	55	22.56	47	0.73	12
2	1¼ to 1	1.60	59	41	24.96	41	.78	12
3	1 to ¾	1.65	59	41	27.68	35	.72	12
4	¾ to ½	1.70	61	39	27.90	34	.70	12

Washing tests.

	Test 187.	Test 187a.		Test 187.	Test 187a.
Size as used, through screen.....	2-inch.	2-inch.	Raw coal.....tons..	18	5.5
Jig adjustment:			Washed coal..{....do...	9	3.3
Make or number.....	Stewart.	Stewart.	{per cent..	50	60
Speed.....r. p. m..	35	35	Refuse.....{...tons..	9	2.2
Stroke.....inches..	6	6	{per cent..	50	40

Analyses.

Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur.	
			Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
Raw coal, car sample	4060	7.10	42.56	.....	0.82	.....
Washed coal, test 187	4123	17.29	29.67	30	.64	22
Washed coal, test 187a	4344	22.73	34.57	19	.55	33

BRIQUETTING TEST.

Argentina No. 1 (run of mine, washed).

Test 180.—Size as used: Over $\frac{1}{4}$ inch, 3 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 8.4 per cent $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 15 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 19.2 per cent; through $\frac{1}{40}$ inch, 54.4 per cent. Briquets very heavy and hard, and gave rough fracture without crumbling when broken, as the coal particles were firmly cemented together and could be handled when warm without breaking. For analyses of briquets see page 61 (steaming test 485).

Details of manufacture:		Drop test (1-inch screen):	
Machine used	Renf.	Held ..... per cent.	84.5
Temperature of briquets ..... °F.	185	Passed ..... do	15.5
Binder—		Tumbler test (1-inch screen):	
Kind	w. g. p.	Held ..... do	91.2
Laboratory No. (see p. 40)	4543	Passed (fines) ..... do	8.8
Amount ..... per cent.	7	Fines through 10-mesh sieve ... do	94.0
Weight of—		Weathering test:	
Fuel briquetted ..... pounds.	6,000	Time exposed ..... days.	19
Briquets, average ..... do	0.603	Condition	A
Heat value per pound—		Water absorption:	
Fuel as received ..... B. t. u.	6,930	In 19 days ..... per cent.	9.8
Fuel as fired ..... do	7,515	Average for first 4 days ..... do	1.44
Binder ..... do	16,969	Specific gravity (apparent)	1.467

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 180.
Laboratory No	4543	4344	.....
Air-drying loss ..... per cent.	.....	18.50	4.30
Extracted by CS_2:			
Air-dried ..... do	.....	.08	6.38
As received ..... do	99.66	.06	6.10
Pitch in briquets, as received ..... do	.....	.....	6.06

ARKANSAS.

ARKANSAS NO. 1.[a]

Bituminous coal from Huntington, Sebastian County, on the Frisco System, was designated Arkansas No. 1 B. The coal as worked at a depth of 110 feet at this place averages 7 feet in thickness.

This sample consisted of slack coal. It was loaded under the supervision of John W. Groves, and was used in making washing test 139; coking tests 95, 96, 97, and 100 (washed), and cupola tests 96 and 115.

Two mine samples were taken for chemical analysis. Sample 2586 was cut 900 feet west of the shaft, where the coal measured 7 feet 9 inches in thickness. Sample 2585 was cut one-half mile south of the shaft, where the coal measured 7 feet 3 inches in thickness.

[a] For other tests on coal from this locality made in 1904, see Bull. U. S. Geol. Survey No. 261, 1905, pp. 33, 80, 122, and 148; and Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 42, 198, 345, 1328, 1430.

CHEMICAL ANALYSES.

Arkansas No. 1 B.

	Mine samples.		Car sample.
Laboratory No	2585	2586	2689
Air-drying loss	2.90	3.50	6.70
Proximate:			
Moisture	3.53	4.00	7.49
Volatile matter	16.66	16.82	15.16
Fixed carbon	72.04	72.04	59.38
Ash	7.77	7.14	17.97
Sulphur	1.29	1.32	1.06
Ultimate:			
Hydrogen			4.34
Carbon			65.54
Nitrogen			1.36
Oxygen			9.73
Calorific value (as received):			
Determined, calories	7,787		6,316
Determined, B. t. u.	14,017		11,369
Calculated from ultimate analysis, calories			6,394
Calculated from ultimate analysis, B. t. u.			11,509

WASHING AND COKING TESTS.

Arkansas No. 1 B (slack).

Washing test 139.—Jig used, Stewart. Raw coal, 61,190 pounds; washed, 46,000 pounds; refuse, 15,190 pounds.

Coking tests (on washed coal).

	Test 95.	Test 96.	Test 97.[a]	Test 100.[b]
Size as used	s.	f. c.	f. c.	f. c.
Duration of test, hours	49	71	48	50
Coal charged, pounds	10,000	10,000	10,000	10,000
Coke produced, do	5,832	5,806	6,055	5,976
Coke produced, per cent	58.32	58.06	60.55	59.76
Breeze produced, pounds	574	1,290	214	391
Breeze produced, per cent	5.74	12.90	2.14	3.91
Total yield, do	64.06	70.96	62.69	63.67

[a] Plus 10 per cent pitch. [b] Plus 15 per cent pitch.

Remarks.—Test 95: Soft and punky; dense; breakage very irregular; large and small lumps. Test 96: Soft and punky with no cell structure; very soft and dense coke. This test was run slowly to save burning fixed carbon and to compare with test 95. Could not get heat, and noncementing action, due to this cause, probably accounts for high breeze. Test 97: Dull-gray color; dense; breakage very bad and irregular; large and small chunks. Test 100: Dull-gray color; soft and punky; dense; practically same as test 97, possibly a little better.

Analyses.

	Washing test 139.		Coking test 95.		Coking test 96.		Coking test 97.		Coking test 100.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	7.49	6.32	10.96	2.89	6.77	1.31	7.80	2.74	5.69	0.18
Volatile matter	15.16		16.66	3.67	15.04	2.44	18.93	1.29	17.34	2.03
Fixed carbon	59.38		66.51	85.23	69.32	84.53	64.92	85.81	68.67	87.26
Ash	17.97	8.62	5.87	8.21	8.87	11.72	8.35	10.16	8.30	10.53
Sulphur	1.06	1.12	1.01	1.25	1.14	1.11	1.08	1.02	1.12	1.07

Cupola tests of coke made from Arkansas No. 1 B coal (washed, plus 10 per cent pitch).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
96	97	1.96	7	93.06	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750
115	97	1.96	7	94.44	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Maximum.	Iron running in—	Weight of iron. Poured.	Additional melted.	Total.	Melting. Time.	Rate per hour.	Ratio iron to coke.	Loss.	Recovered. Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
96	3.50 p. m.	7	8	1,663	319	1,982	36	3,303	5.33	9.60	730	58
115	3.33 p. m.	7	14	1,648	404	2,052	25	4,925	5.58	10.70	627	62

LADLE RECORD.

Ladle No.	Test 96. Pounds.	Time (p. m.).	Test 115. Pounds.	Time (p. m.).	Ladle No.	Test 96. Pounds.	Time (p. m.).	Test 115. Pounds.	Time (p. m.).
1	64	4.02	106	3.57	12	108	4.22	100	4.10½
2	78	4.07	107	3.57½	13	115	4.22½	126	4.11
3	85	4.07½	104	3.58	14	61	4.23	95	4.11½
4	65	4.12	110	4.05	15	97	4.24	94	4.12
5	73	4.12½	112	4.06	16	112	4.24½	.....	.....
6	41	4.13	111	4.06½	17	58	4.25	.....	.....
7	79	4.13½	129	4.07	18	77	4.28	.....	.....
8	70	4.14	107	4.07½	19	98	4.28½	.....	.....
9	70	4.19	128	4.08	20	55	4.29	.....	.....
10	75	4.19½	111	4.09	21	80	4.31	.....	.....
11	61	4.20	108	4.10	22	41	4.34	.....	.....

[a] Phosphorus in coke, 0.0135 per cent; sulphur in ash, 0.05 per cent.

Remarks.—Test 96: Iron hot. Test 115: Iron hot; bed burned out and charges hung; bottom had to be dropped after the fifteenth ladle.

ARKANSAS NO. 7.

Bituminous coal from a mine located 4 miles southwest of Midland, Sebastian County, on the Midland Valley Railroad, was designated Arkansas No. 7. The coal as worked at a depth of 190 feet at this place averages 7 feet 6 inches in thickness.

Two lots of coal were shipped from this mine under the supervision of John W. Groves. Arkansas No. 7 A consisted of domestic lump which had passed over a 2-inch perforated screen. It was used in making steaming tests 293 and 294 and producer-gas test 96. Arkansas No. 7 B consisted of slack coal which had passed through a 2-inch

perforated screen. It was used in making washing test 141, coking tests 104 and 105, cupola tests 116 and 142, and briquetting test 106.

Two mine samples were taken for chemical analysis. Sample 2593 was cut 950 feet northwest of the foot of the slope, where the coal measured 8 feet in thickness. Sample 2594 was taken 900 feet northeast of the foot of the slope, where the coal measured 7 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Arkansas No. 7.

	Mine samples.		Car samples.		Steaming tests.[a]	
			A.	B.	293	294
Laboratory No.	2593	2594	2688	2722	.....	.....
Air-drying loss	3.50	4.90	4.90	5.90	.....	.....
Proximate:						
Moisture	3.97	5.38	5.47	6.89	5.41	5.55
Volatile matter	16.86	16.02	16.27	15.23	16.10	15.88
Fixed carbon	73.26	69.76	66.57	62.88	68.34	67.40
Ash	5.91	8.84	11.69	15.00	10.15	11.17
Sulphur	1.53	3.20	2.02	2.24	1.81	1.86
Ultimate:						
Hydrogen	.....	.....	4.33	4.44	4.03	3.97
Carbon	.....	.....	72.63	68.28	78.49	77.47
Nitrogen	.....	.....	1.26	1.26	1.36	1.34
Oxygen	.....	.....	8.07	8.78	3.48	3.42
Ash	.....	.....	.....	.....	10.73	11.83
Sulphur	.....	.....	.....	.....	1.91	1.97
Calorific value (as received):						
Determined (Calories)	7,909	.....	7,050	6,700	.....	.....
Determined (B. t. u.)	14,236	.....	12,690	12,060	.....	.....
Calculated from ultimate analysis (Calories)	.....	.....	7,058	6,718	.....	.....
Calculated from ultimate analysis (B. t. u.)	.....	.....	12,704	12,092	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Arkansas No. 7 A (lump).

	Test 293.	Test 294.
Size as used:		
Over 1 inch ..... per cent	6.3	7.0
½ inch to 1 inch ..... do	11.9	8.8
¼ inch to ½ inch ..... do	18.5	14.1
Under ¼ inch ..... do	63.3	70.1
Duration of test ..... hours	9.8	10.0
Heating value of coal ..... B. t. u. per pound of dry coal	13,705	13,531
Force of draft:		
Under stack damper ..... inch water	0.62	0.62
Above fire ..... do	.15	.....
In ash pit (forced draft) ..... do	.....	.25
Furnace temperature ..... °F	1,972	2,060
Dry coal used per square foot of grate surface per hour ..... pounds	13.71	17.34
Equivalent water evaporated per square foot of water-heating surface per hour ..... pounds	2.60	3.06
Percentage of rated horsepower of boiler developed	72.8	85.7
Water apparently evaporated per pound of coal as fired ..... pounds	7.55	7.01
Water evaporated from and at 212° F.:		
Per pound of coal as fired ..... do	8.97	8.35
Per pound of dry coal ..... do	9.48	8.84
Per pound of combustible ..... do	11.02	10.34
Efficiency of boiler, including grate ..... per cent	66.80	63.09
Coal as fired:		
Per indicated horsepower hour ..... pounds	3.15	3.39
Per electrical horsepower hour ..... do	3.89	4.18
Dry coal:		
Per indicated horsepower hour ..... do	2.98	3.20
Per electrical horsepower hour ..... do	3.68	3.95

PRODUCER-GAS TEST.

Arkansas No. 7 A (lump).

Test 96.—Size as used: Over 1 inch, 28 per cent; ½ inch to 1 inch, 10 per cent; ¼ inch to ½ inch, 15 per cent; under ¼ inch, 47 per cent. Duration of test, 50 hours; average electrical horsepower, 137.3; average B. t. u. per cubic foot of gas, 125.5; total coal fired, 12,900 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.06	1.97	1.72
Developed at switch board	1.88	1.80	1.57
Per brake horsepower:			
Commercially available	1.75	1.67	1.46
Developed at engine	1.60	1.53	1.34
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.24	2.14	1.87
Developed at switch board	2.04	1.96	1.71
Per brake horsepower:			
Commercially available	1.90	1.82	1.59
Developed at engine	1.74	1.66	1.45

Analyses.

Coal.		*Gas by volume.*	
Moisture	4.27	Carbon dioxide (CO_2)	14.8
Volatile matter	16.04	Carbon monoxide (CO)	12.1
Fixed carbon	67.43	Hydrogen (H_2)	16.1
Ash	12.26	Methane (CH_4)	1.6
Sulphur	2.15	Nitrogen (N_2)	55.4

WASHING AND COKING TESTS.

Arkansas No. 7 B (slack).

Washing test 141.—Jig used, Stewart. Raw coal, 50,000 pounds; washed, 38,000 pounds; refuse, 12,000 pounds.

Coking tests (on washed coal).

		Test 104.	Test 105.[a]
Size as used		s.	f. c.
Duration of test	hours.	67	57
Coal charged	pounds.	10,000	10,000
Coke produced	do.	2,730	4,868
	per cent.	27.30	48.68
Breeze produced	pounds.	3,750	1,604
	per cent.	37.50	16.04
Total yield	do.	64.80	64.72

[a] Plus 5 per cent pitch.

Remarks.—Test 104: Dull-gray color; very soft and light weight; breaking up in oven, on pulling, into large and small chunks; has appearance of being cemented together after volatile was driven off; practically no cell structure; high yield of breeze due to noncementing action, all volatile, as analysis shows, being driven off finely crushing before charging. Test 105: Soft and punky; very dense; dull and not gray color; physically better than coke from coal without pitch; percentage of breeze very high; breaks into large and small chunks; better weight than coke in test 104, but light.

Analyses.

	Washing test 141.		Coking test 104.		Coking test 105.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	6.89	6.45	6.98	0.13	7.52	0.67
Volatile matter	15.23	.....	14.86	.53	16.66	.85
Fixed carbon	62.88	.....	70.97	89.72	68.85	89.14
Ash	15.00	7.19	7.19	9.62	6.97	9.34
Sulphur	2.24	1.89	1.78	1.70	1.65	1.60

Cupola tests of coke made from Arkansas No. 7 B coal (washed, plus 5 per cent pitch).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
116	105	1.97	7	99.9	Coke	220	53	53	52	52	430
					Pig iron	660	398	398	397	397	2,250
					Scrap	220	133	133	132	132	750
142	105	197	7	93.05	Coke	220	53	53	52	52	430
					Pig iron	660	398	398	397	397	2,250
					Scrap	220	133	133	132	132	750

[a] Phosphorus in coke, 0.0135 per cent; sulphur in ash, 0.07 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
116	10.41 a. m.	7	12	772	318	1,090	33	1,982	3.25	3.13	1,816	95
142	10.55 a. m.	7	6	1,637	399	2,036	35	3,490	5.72	7.60	736	74

LADLE RECORD.

Ladle No.	Test 116. Pounds.	Test 116. Time (a. m.).	Test 142. Pounds.	Test 142. Time (a. m.).	Ladle No.	Test 116. Pounds.	Test 116. Time (a. m.).	Test 142. Pounds.	Test 142. Time (a. m.).
1	83	11.05	81	11.07	12			83	11.24
2	94	11.06	87	11.10	13			64	11.25
3	74	11.11	75	11.10½	14			104	11.25½
4	90	11.12	73	11.12	15			77	11.26
5	97	11.12½	70	11.12½	16			55	11.28
6	23	11.13	80	11.17	17			98	11.28½
7	65	11.17	75	11.17½	18			72	11.29
8	72	11.17½	80	11.18	19			58	11.33
9	89	11.18	84	11.19	20			63	11.33½
10	61	11.25	61	11.23	21			58	11.34
11	24	11.26	99	11.23½	22			40	11.36

Remarks.—Test 116: Iron hot; charges hung and bottom dropped after eleventh ladle. Test 142: Iron medium temperature.

BRIQUETTING TEST.

Arkansas No. 7 B (washed slack).

Test 106.—Machine used, English. Temperature of briquets, 179.6° F. Kind of binder,[a] coal-tar pitch; laboratory No. 2735 (see p. 40). Amount of binder, 4, 5, and 6 per cent. Weight of fuel briquetted, 4,000 pounds.

Briquets made with 4, 5, and 6 per cent of binder were equally satisfactory, with hard, fine structure, glossy fracture, and well-molded, sharp edges. In the drop test with 4 per cent binder the 1-inch screen held 31.4 per cent and passed 68.6 per cent. In the weathering test all binders were exposed 80 days; condition for the 4 per cent C, for the others B.

ARKANSAS NO. 8.

Semianthracite coal from Spadra, Johnson County, on the St. Louis, Iron Mountain and Southern Railway, was designated Arkansas No. 8. The coal as worked at a depth of 87 feet at this place averages 2 feet 10 inches in thickness.

The sample, which was shipped under the supervision of W. J. Von Borries, consisted of No. 4 coal screened on a 1¼-inch round perforated screen. It was used in making steaming tests 297, 308, and (washed coal) 309; producer-gas test 95, and washing test 144.

Two mine samples were taken for chemical analysis. Sample 2587 was cut 1,300 feet northeast of the shaft, where the coal measured 2 feet 11 inches in thickness. Sample 2588 was cut 1,650 feet northwest of the shaft, where the coal measured 2 feet 11½ inches in thickness.

CHEMICAL ANALYSES.

Arkansas No. 8.

	Mine samples.		Car sample.	Steaming tests.[b]		
				297.	308.	309.
Laboratory number	2587	2588	2744			
Air-drying loss	2.50	2.10	4.40			
Proximate:						
Moisture	3.12	2.72	5.19	3.24	5.93	5.93
Volatile matter	11.39	11.20	10.49	9.90	11.21	10.79
Fixed carbon	77.03	77.71	70.31	71.93	74.80	75.43
Ash	8.46	8.37	14.01	14.93	8.06	7.85
Sulphur	1.84	2.78	2.05	2.46	2.08	2.03
Ultimate:						
Hydrogen			3.78	3.34	3.63	3.64
Carbon			72.43	75.46	82.06	82.30
Nitrogen			.51	.53	.57	.59
Oxygen			7.22	2.70	2.96	2.97
Ash				15.43	8.57	8.34
Sulphur				2.54	2.21	2.16
Calorific value (as received):						
Determined { calories	7,607		6,922			
Determined { B. t. u.	13,793		12,460			
Calculated from ultimate analysis { calories			6,891			
Calculated from ultimate analysis { B. t. u.			12,404			

[a] The flowing point of the binder used was 188.8° F., and 58.56 per cent of the sample as received was extracted by CS_2. All other data concerning this binder were lost in the fire.

[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Arkansas No. 8 (washed).

	Test 297.	Test 308.	Test 309.
Size as used:			
Over 1 inch.....per cent..	46.6	24.0	15.4
½ inch to 1 inch.....do....	16.0	17.0	14.8
¼ inch to ½ inch.....do....	8.7	18.0	18.5
Under ¼ inch.....do....	28.7	41.0	15.3
Duration of test.....hours..	9.72	5.03	5.03
Heating value of coal.....B. t. u. per pound of dry coal..	13,000	14,125	14,153
Force of draft:			
Under stack damper.....inch water..	0.63	0.72	0.62
Above fire.....do....	.....	(a)	.....
In ash pit.....do....	b.03	.....	(b)
Furnace temperature.....°F..	1,964	1,961	2,403
Dry coal used per square foot of grate surface per hour.....pounds..	18.55	16.13	22.12
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.03	2.89	3.79
Percentage of rated horsepower of boiler developed.....	85.0	80.9	106.3
Water apparently evaporated per pound of coal as fired.....pounds..	6.69	7.01	6.69
Water evaporated from and at 212° F.:			
Per pound of coal as fired.....do....	7.93	8.42	8.08
Per pound of dry coal.....do....	8.19	8.96	8.59
Per pound of combustible.....do....	10.49	10.82	10.06
Efficiency of boiler, including grate.....per cent..	60.84	61.26	58.61
Coal as fired:			
Per indicated horsepower hour.....pounds..	3.57	3.36	3.50
Per electrical horsepower hour.....do....	4.40	4.15	4.32
Dry coal:			
Per indicated horsepower hour.....do....	3.45	3.16	3.29
Per electrical horsepower hour.....do....	4.26	3.90	4.07

a Natural draft. b Forced draft.

PRODUCER-GAS TEST.

Arkansas No. 8.

Test 95.—Size as shipped, 4 inches; size as used: Over 1 inch, 68 per cent; ½ inch to 1 inch, 13 per cent; ¼ inch to ½ inch, 6 per cent; under ¼ inch, 13 per cent. Duration of test, 26 hours; average electrical horsepower, 177.2; average B. t. u. per cubic foot of gas, 130; total coal fired, 8,550 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.96	1.90	1.60
Developed at switchboard	1.86	1.81	1.52
Per brake horsepower:			
Commercially available	1.66	1.62	1.36
Developed at engine	1.58	1.54	1.29
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.13	2.07	1.74
Developed at switchboard	2.02	1.97	1.65
Per brake horsepower:			
Commercially available	1.81	1.76	1.48
Developed at engine	1.72	1.67	1.40

Analyses.

Coal.		*Gas by volume.*	
Moisture	2.74	Carbon dioxide (CO_2)	11.3
Volatile matter	9.70	Carbon monoxide (CO)	15.9
Fixed carbon	71.95	Hydrogen (H_2)	14.7
Ash	15.61	Methane (CH_4)	1.0
		Nitrogen (N_2)	56.7
Sulphur	2.45	Oxygen (O_2)	.2
		Ethylene (C_2H_4)	.2

WASHING TESTS.

Arkansas No. 8.

Test 144.—Size as shipped and used, No. 4 nut. Jig used, Stewart. Raw coal, 23,000 pounds; washed, 19,570 pounds; refuse, 3,430 pounds.

Analyses.—Raw coal: See car sample No. 2744 (p. 69). Washed coal: Moisture, 5.03; ash, 7.85; sulphur, 2.03.

ARKANSAS NO. 9.

Bituminous coal from Bonanza, Sebastian County, on the Frisco System, was designated Arkansas No. 9. The coal, as worked at a depth of 350 feet at this place, averages 3 feet 3 inches in thickness.

This sample consisted of slack coal through a 1⅛-inch bar screen. It was shipped under the supervision of John W. Groves, and the following tests were made: Washing test, 140; coking tests, 98, 99, 101, 102, and 103 on washed coal; and cupola tests 95 and 117.

Two mine samples were taken for chemical analysis. Sample 2599 was cut 1,400 feet southeast of the shaft, where the coal measured 3 feet 1½ inches in thickness. Sample 2600 was cut 1,100 feet west of the shaft, where the coal measured 3 feet 2 inches in thickness.

CHEMICAL ANALYSES.

Arkansas No. 9.

	Mine samples.		Car sample.
Laboratory No.	2599	2600	2690
Air-drying loss	1.70	1.80	4.20
Proximate:			
Moisture	1.99	2.12	5.26
Volatile matter	15.90	16.17	14.71
Fixed carbon	75.05	75.01	55.22
Ash	7.06	6.70	24.81
Sulphur	1.05	1.78	1.00
Ultimate:			
Hydrogen			3.91
Carbon			59.87
Nitrogen			1.23
Oxygen			9.18
Calorific value (as received):			
Determined, calories	7,826		5,806
Determined, B. t. u.	14,087		10,451
Calculated from ultimate analysis, calories			5,812
Calculated from ultimate analysis, B. t. u.			10,462

WASHING AND COKING TESTS.

Arkansas No. 9 (slack).

Washing test 140.—Jig used, Stewart. Raw coal, 77,300 pounds; washed, 57,350 pounds; refuse, 19,950 pounds.

Coking tests (on washed coal).

	Test 98.	Test 99.	Test 101.[a]	Test 102.[b]	Test 103.[c]
Size as shipped, inches	1⅛	1⅛	1⅛	1⅛	1⅛
Size as used, do	f. c.	1⅛	f. c.	f. c.	1⅛
Duration of test, hours	28	24	39	43	46
Coal charged, pounds				10,000	10,000
Coke produced, do				6,252	5,107
Coke produced, per cent				62.52	51.07
Breeze produced, pounds				458	1,693
Breeze produced, per cent				4.58	16.93
Total yield, do				67.10	68.00

[a] Plus 3.44 per cent asphalt. [b] Plus 10 per cent pitch. [c] Plus 5 per cent pitch.

Remarks.—Test 98: No coke produced; ashed down about 5 inches. Test 99 on washed slack not crushed gave same result; no coke. Test 101: No coke produced; ashed down about 6 inches. Test 102: Dull-gray color; soft and punky; dense with good weight; breakage very irregular, large and small chunks. Test 103: Very soft and punky; has appearance of being cemented together after volatile was driven off; high yield of breeze due to noncementing action, all volatile being driven off; 5 per cent pitch, not enough, as results from test 102, 10 per cent pitch, show.

Analyses.

	Washing test 140.		Coking test 98 (coal).	Coking test 101 (coal).	Coking test 102.		Coking test 103.	
	Raw coal.	Washed. coal.			Coal.	Coke.	Coal.	Coke.
Moisture	5.26	7.78	7.43	6.30	5.60	0.30	5.76	0.33
Volatile matter	14.71	.....	13.84	14.74	17.22	.81	14.84	.80
Fixed carbon	55.22	.....	65.55	65.01	64.03	81.48	66.63	83.70
Ash	24.81	14.30	13.18	13.95	13.15	17.41	12.77	15.17
Sulphur	1.00	.98	.96	.98	1.01	1.07	1.02	1.07

Cupola tests of coke made from Arkansas No. 9 coal, washed, plus 10 per cent pitch.

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
95	102	2.04	7	88.89	Coke	210	55	55	55	55	430
					Pig iron	630	405	405	405	405	2,250
					Scrap	210	135	135	135	135	750
117	102	2.04	7	98.61	Coke	220	53	53	52	52	430
					Pig iron	660	398	398	397	397	2,250
					Scrap	220	133	133	132	132	750

RECORD OF MELT.

Cupola test. No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
95	10.50 a. m.	7	12	679	354	1,033	28	2,214	3.56	5.07	1,815	140
117	8.02 a. m.	6½	16	1,005	288	1,293	25	3,103	4.01	8.10	1,464	108

LADLE RECORD.

Ladle No.	Test 95. Pounds.	Test 95. Time (a. m.).	Test 117. Pounds.	Test 117. Time (a. m.).	Ladle No.	Test 95. Pounds.	Test 95. Time (a. m.).	Test 117. Pounds.	Test 117. Time (a. m.).
1	82	11.16	78	8.26	10	61	11.30	77	8.38
2	50	11.19	52	8.31	11	.....	.....	54	8.38½
3	92	11.19½	53	8.31½	12	.....	.....	55	8.39
4	53	11.20	70	8.32	13	.....	.....	64	8.39½
5	58	11.26	67	8.32½	14	.....	.....	70	8.41½
6	72	11.26½	37	8.34	15	.....	.....	48	8.42
7	91	11.27	60	8.34½	16	.....	.....	45	8.42½
8	61	11.29	66	8.35	17	.....	.....	26	8.43
9	59	11.29½	83	8.35½					

[a] Phosphorus in coke, 0.0329 per cent; sulphur in ash, 0.17 per cent.

Remarks.—Test 95: Iron cold and dull. Test 117: Iron hot and fluid.

ARKANSAS NO. 10.

Lignite from a mine located 7 miles west of Lester, Ouachita County, on the St. Louis, Iron Mountain and Southern Railway, was designated Arkansas No. 10. The lignite, as worked from the outcrop at this place, averages 5 feet 6 inches in thickness.

This sample consisted of run-of-mine lignite and was shipped under the supervision of John W. Groves. It was used in steaming test 340 and producer-gas test 91.

Two mine samples were taken for chemical analysis. Sample 2647 was taken 300 feet from the drift mouth, where the coal measured 6 feet 6 inches in thickness. Sample 2648 was taken in the air course 300 feet from the drift mouth, where the coal measured 5 feet in thickness.

CHEMICAL ANALYSES.

Arkansas No. 10.

	Mine samples.		Car sample.[a]	Steaming test 340.[b]
Laboratory No.	2647	2648	2726	.....
Air-drying loss	32.60	35.70	25.10	.....
Proximate:				
Moisture	39.50	41.25	39.43	38.75
Volatile matter	25.35	27.96	26.49	25.82
Fixed carbon	22.57	22.98	24.37	22.20
Ash	12.58	7.81	9.71	13.23
Sulphur	.53	.50	.49	.57
Ultimate:				
Hydrogen	.....	.....	6.98	4.00
Carbon	.....	.....	36.33	55.88
Nitrogen	.....	.....	.68	1.04
Oxygen	.....	.....	45.81	16.55
Ash	.....	.....	.....	21.60
Sulphur	.....	.....	.....	.93
Calorific value (as received):				
Determined, calories	3,265	.....	3,531	.....
Determined, B. t. u.	5,877	.....	6,356	.....
Calculated from ultimate analysis, calories	.....	.....	3,377	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	6,079	.....

[a] Car sample figured from producer-gas test 91.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Arkansas No. 10 (run of mine).

	Test 340.
Size as used:	
3 inch to 1½ inch, per cent	36.3
1½ inch to 1 inch, do	8.1
½ inch to 1 inch, do	19.3
¼ inch to ½ inch, do	15.0
Under ¼ inch, do	21.3
Duration of test, hours	9.0
Heating value of fuel, B. t. u. per pound dry fuel	9,549
Force of draft:	
Under stack damper, inch water	.82
Above fire, do	[a] .12
Dry fuel used per square foot of grate surface per hour, pounds	35.33
Equivalent water evaporated per square foot of water-heating surface per hour, do	3.71
Percentage of rated horsepower of boiler developed	[b] 104.0
Water apparently evaporated per pound of fuel as fired, pounds	2.99

[a] Forced draft. [b] Test represents maximum capacity.

STEAMING TEST—Continued.

Arkansas No. 10 (run of mine).

	Test 340.
Water evaporated from and at 212° F.:	
Per pound of fuel as fired ..... pounds..	3.59
Per pound of dry fuel ..... do....	5.86
Per pound of combustible ..... do....	7.60
Efficiency of boiler, including grate ..... per cent..	59.26
Fuel as fired:	
Per indicated horsepower hour ..... pounds..	7.88
Per electrical horsepower hour ..... do....	9.72
Dry fuel:	
Per indicated horsepower hour ..... do....	4.83
Per electrical horsepower hour ..... do....	5.96

PRODUCER-GAS TEST.

Arkansas No. 10 (run of mine).

Test 91.—Duration of test, 18 hours. Average electrical horsepower, 128.7. Average B. t. u. per cubic foot of gas, 125.3. Total coal fired, 8,250 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	3.87	2.34	1.96
Developed at switch board	3.56	2.16	1.81
Per brake horsepower:			
Commercially available	3.29	1.99	1.67
Developed at engine	3.03	1.83	1.54
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	4.41	2.67	2.24
Developed at switch board	4.07	2.46	2.07
Per brake horsepower:			
Commercially available	3.75	2.27	1.91
Developed at engine	3.45	2.09	1.76

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	13.5
Carbon monoxide (CO)	14.0
Hydrogen (H_2)	9.2
Methane (HC_4)	2.4
Nitrogen (N_2)	60.9

ARKANSAS NO. 13.

Bituminous slack from mines at Denning, on the St. Louis, Iron Mountain and Southern Railway, was designated Arkansas No. 13.

Three cars (100 tons) of this coal were shipped by the operator uninspected, and used for briquetting tests 164[b], 214, and 221.

[a] For analysis of coal see p. 73 (car sample No. 2726).

[b] Briquets from this test were used in water-gas machine test. (See p. 44.)

CHEMICAL ANALYSES.

Arkansas No. 13.

	Car sample.	Briquetting tests.[a]		
		164†.	214.	221.
Labratory No.	3798			4626
Air-drying loss	1.70			0.80
Proximate:				
Moisture	2.91	1.49	1.05	1.76
Volatile matter	12.65	15.11	16.50	15.98
Fixed carbon	66.93	68.30	68.84	67.30
Ash	17.51	15.10	13.61	14.96
Sulphur		2.58	2.48	2.29
Ultimate:				
Hydrogen	3.60	3.84	3.85	3.84
Carbon	70.88	75.03	75.63	75.65
Nitrogen	1.17	1.35	1.24	1.24
Oxygen	3.72	1.83	1.70	1.71
Ash	17.51	15.33	15.23	15.23
Sulphur	3.12	2.62	2.33	2.33
Calorific value (as received):				
Determined, calories	6,840			7,181
Determined, B. t. u.	12,312			12,926
Calculated from ultimate analysis, calories	6,876			
Calculated from ultimate analysis, B. t. u.	12,377			

[a] Proximate analysis of coal as received; ultimate analysis on dry basis.

BRIQUETTING TESTS.

Arkansas No. 13 (slack).

Tests 164†, 214, 221.—Size as used: Over ¼ inch, 1.4 per cent; $\frac{1}{10}$ inch to ¼ inch, 6.2 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 10.6 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 15.8 per cent; through $\frac{1}{40}$ inch, 66 per cent. There was no apparent difference in appearance between briquets made with 7 and 8 per cent binder. Both were excellent briquets, with hard, smooth surface, clean fracture, easily handled, and piled while warm. Less binder could be used with increased pressure. The briquets with 8 per cent binder made less slack in handling when cold. Those with 9 per cent binder were not satisfactory, as the pitch used had a much higher melting point and could not be successfully worked at the pressure available.

	Test 164†.[a]	Test 214.	Test 221.
Details of manufacture:			
Machine used	Renf.	Renf.	Renf.
Temperature of briquets, °F.	185	185	185
Binder—			
Kind	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	3885	3885 / 4683	4625
Amount, per cent	7	8	9
Weight of—			
Fuel briquetted, pounds	140,000	40,000	5,000
Briquets, average, do	0.451	0.464	0.489
Heat value per pound—			
Fuel as received, B. t. u.	12,312	12,312	12,312
Fuel as fired, do	12,917	12,926	
Binder, do	16,870	16,812	16,576
Drop test (1-inch screen):			
Held, per cent	54.5	49.5	51.0
Passed, do	45.5	50.5	49.0
Tumbler test (1-inch screen):			
Held, do	79.0	81.5	86.0
Passed (fines), do	21.0	18.5	14.0
Fines through 10-mesh sieve, do	87.7	87.3	88.9
Weathering test:			
Time exposed, days	106		
Condition	B.		
Water absorption:			
In 19 days, per cent	17.2		
In 13 days, do		13.6	10.2
Average for first 5 days, do	2.50	2.36	1.72
Specific gravity (apparent)	1.130	1.161	1.247

[a] Briquets from this test were used in water-gas machine test (p. 44).

Extraction analyses.

	Pitches.			Fuel.	Briquets.	
					Test 164.	Tests 214, 221.
Laboratory No.	3885	4625	4683	3798	4892	4626
Air-drying loss, ...per cent.				1.70	0.70	0.80
Extracted by CS_2:						
Air dried....do....				.10	5.80	6.34
As received....do....	95.20	90.56	89.31	.09	5.76	6.29
Pitch in briquets, as received....do....					5.97	6.63

FLORIDA.

FLORIDA NO. 1.

Peat from a bog located at Orlando, Orange County, on the Seaboard Air Line Railway, was designated Florida No. 1.

This sample consisted of machined peat made by a commercial process and sun dried, and was used in steaming test 386 and producer-gas test 117.

By this process the peat first passes through a condenser, which disintegrates the material and destroys the fiber. From the condenser the peat is elevated to a molding machine, consisting of a cylinder and two vertical molding wheels. Through the cylinder passes a vertical shaft to which are attached revolving arms set in a screw form. Between these arms perforated plates are set. The peat passing into the top of the cylinder is forced down through the plates to the molding wheel. From the molding wheel the bricks, which are 8 by 4 by $2\frac{1}{2}$ inches, are dropped on boards which are being continually pushed under the machine by a link-belt carrier. These boards, containing 6 bricks each, are loaded on wagons, 50 to the load, and are hauled to the drying ground, where they are allowed to lose from 60 to 75 per cent of their moisture content.

Two samples were taken for analysis. Sample 3268 is raw peat just as it comes from the bog, and sample 3269 is one of the bricks as it came from the machine before delivery to the drying ground.

CHEMICAL ANALYSES.

Florida No. 1.

	Bog samples.		Car sample.[a]	Steaming test 386.[b]
Laboratory No.	3268	3269	3270	.....
Air-drying loss	91.70	84.70	9.00	.....
Proximate:				
Moisture	92.41	88.40	21.00	17.21
Volatile matter	4.68	7.28	51.72	51.01
Fixed carbon	2.58	3.57	22.11	24.85
Ash	.33	.75	5.17	6.93
Sulphur	.05	.08	.45	.49
Ultimate:				
Hydrogen	.....	.....	6.51	5.18
Carbon	.....	.....	46.57	57.77
Nitrogen	.....	.....	2.33	2.89
Oxygen	.....	.....	38.97	25.20
Ash	.....	.....	.....	8.37
Sulphur	.....	.....	.....	.59
Calorific value (as received):				
Determined, calories	.....	.....	4,515	.....
Determined, B. t. u.	.....	.....	8,127	.....
Calculated from ultimate analysis, calories	.....	.....	4,338	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	7,808	.....

[a] Figured from sample taken from producer-gas test 117.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Florida No. 1 (compressed peat).

	Test 386.
Duration of test, hours	4.07
Heating value of fuel, B. t. u. per pound of dry fuel	10,082
Force of draft:	
Under stack damper, inch water	0.69
Above fire, do	.13
Furnace temperature, °F.	2,457
Dry fuel used per square foot of grate surface per hour, pounds	33.49
Equivalent water evaporated per square foot of water-heating surface per hour, do	4.04
Percentage of rated horsepower of boiler developed	113.2
Water apparently evaporated per pound of fuel as fired, pounds	4.27
Water evaporated from and at 212° F.:	
Per pound of fuel as fired, do	5.00
Per pound of dry fuel, do	6.04
Per pound of combustible, do	6.63
Efficiency of boiler, including grate, per cent	57.85
Fuel as fired:	
Per indicated horsepower hour, pounds	5.66
Per electrical horsepower hour, do	6.98
Dry fuel:	
Per indicated horsepower hour, do	4.68
Per electrical horsepower hour, do	5.78

PRODUCER-GAS TEST.

Florida No. 1 (compressed peat).

Test 117.—Duration of test, 50 hours. Average electrical horsepower, 205. Average B. t. u. per cubic foot of gas, 175.2. Total fuel fired, 29,250 pounds.

	Peat as fired.	Dry peat.	Combustible.
Peat consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.98	2.35	2.20
Developed at switchboard	2.85	2.25	2.11
Per brake horsepower:			
Commercially available	2.53	2.00	1.87
Developed at engine	2.43	1.92	1.79
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	3.16	2.50	2.33
Developed at switchboard	3.03	2.39	2.24
Per brake horsepower:			
Commercially available	2.69	2.12	1.98
Developed at engine	2.57	2.03	1.90

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	12.4
Carbon monoxide (CO)	21.0
Hydrogen (H_2)	18.5
Methane (CH_4)	2.2
Nitrogen (N_2)	45.5
Ethylene (C_2H_2)	.4

GEORGIA.

GEORGIA NO. 1.

Bituminous coal from the Little River bed at Menlo, Chattooga County, on the Chattanooga Southern Railway, was designated Georgia No. 1. This coal, as worked from the outcrop at this place, averages 1 foot 11 inches in thickness.

One sample, shipped under the supervision of A. K. Adams, consisted of lump coal over a 1¼-inch perforated stationary screen, and was used in steaming test 481 and coking test 173.

Two mine samples were taken for chemical analysis. Sample 4155 was taken 1,600 feet east of the opening, where the coal measured 2 feet in thickness. Sample 4156 was taken 2,800 feet east of the opening, where the coal measured 1 foot 11 inches in thickness.

CHEMICAL ANALYSES.

Georgia No. 1.

	Mine samples.		Car sample.	Steaming test 481.[b]
Laboratory No.	4155	4156	4320	.....
Air-drying loss	1.90	2.30	3.20	.....
Proximate:				
Moisture	2.40	2.85	3.80	3.11
Volatile matter	18.17	17.14	15.88	16.90
Fixed carbon	70.09	72.17	65.83	62.77
Ash	9.34	7.84	14.49	17.22
Sulphur	1.12	.67	1.27	1.29
Ultimate:				
Hydrogen	.....	.....	4.32	3.92
Carbon	.....	.....	70.59	70.99
Nitrogen	.....	.....	1.09	1.09
Oxygen	.....	.....	8.24	4.90
Ash	.....	.....	.....	17.77
Sulphur	.....	.....	.....	1.33
Calorific value determined (as received) calories	.....	7,888	7,106	.....
Calorific value determined (as received) B. t. u.	.....	14,198	12,791	.....

[a] For analysis of the peat used, see p. 77 (car sample 3270).
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Georgia No. 1.

	Test 481.
Size as used:	
Over 1 inch....per cent..	37.9
½ inch to 1 inch....do....	15.8
¼ inch to ½ inch....do....	14.5
Under ¼ inch....do....	31.8
Average diameter....inch..	0.89
Duration of test....hours..	9.47
Heating value of coal....B. t. u. per pound dry coal..	12,865
Force of draft:	
Under stack damper....inch water..	0.81
Above fire....do....	.19
Dry coal used per square foot of grate surface per hour....pounds..	22.32
Equivalent water evaporated per square foot of water-heating surface per hour....do....	3.99
Percentage of rated horsepower of boiler developed	111.8
Water apparently evaporated per pound of coal as fired....pounds..	7.20
Water evaporated from and at 212° F.:	
Per pound of coal as fired....do....	8.67
Per pound of dry coal....do....	8.95
Per pound of combustible....do....	11.39
Efficiency of boiler, including grate....per cent..	67.18
Coal as fired:	
Per indicated horsepower hour....pounds..	3.26
Per electrical horsepower hour....do....	4.03
Dry coal:	
Per indicated horsepower hour....do....	3.16
Per electrical horsepower hour....do....	3.90

COKING TEST.

Georgia No. 1.

Test 173.—Size as shipped, 1½ inches and larger; as used, raw, finely crushed. Duration of test, 58 hours; coal charged, 12,180 pounds; coke produced, 8,100 pounds, 66.50 per cent; breeze produced, 549 pounds, 4.51 per cent; total yield, 71.01 per cent. Poor, dense coke. Large pieces of irregular size. Washing would probably improve and make fair grade of coke.

Analyses.

	Coal.	Coke.
Moisture	3.35	0.45
Volatile matter	16.54	.35
Fixed carbon	66.07	81.69
Ash	14.04	17.51
Sulphur	1.29	1.00

ILLINOIS.

ILLINOIS NO. 7.[a]

Screened nut coal from a mine near Collinsville was designated Illinois No. 7 E, and was used in steaming test 516 and briquetting test 244†.

[a] For other tests of coal from this mine, made during 1905, see Bull. U. S. Geol. Survey No. 290, 1906, pp. 57-60.

CHEMICAL ANALYSES.

Illinois No. 7 E.

	Steaming test 516.[a]	Briquetting test 244†.[b]		Steaming test 516.[a]	Briquetting test 244†.[b]
Proximate:			Ultimate:		
Moisture	14.47	6.06	Hydrogen	3.84	3.57
Volatile matter	28.14	30.09	Carbon	56.08	59.48
Fixed carbon	35.16	40.34	Nitrogen	.91	.83
Ash	22.23	23.51	Oxygen	8.82	5.67
Sulphur	3.73	5.09	Ash	25.99	25.03
			Sulphur	4.36	5.42

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TEST.

Illinois No. 7 E.

	Test 516.
Size as used:	
Over 1 inch ..... per cent	4.8
½ inch to 1 inch ..... do	24.7
¼ inch to ½ inch ..... do	25.1
Under ¼ inch ..... do	45.4
Average diameter ..... inch	0.47
Duration of test ..... hours	7.85
Heating value of coal ..... B. t. u. per pound dry coal	10,283
Force of draft:	
Under stack damper ..... inch water	0.87
Above fire ..... do	.13
In ash pit	.31
Dry coal used per square foot of grate surface per hour ..... pounds	31.99
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	3.70
Percentage of rated horsepower of boiler developed	103.7
Water apparently evaporated per pound of coal as fired ..... pounds	4.09
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... do	4.95
Per pound of dry coal ..... do	5.79
Per pound of combustible ..... do	8.21
Efficiency of boiler, including grate ..... per cent	54.38
Coal as fired:	
Per indicated horsepower hour ..... pounds	5.71
Per electrical horsepower hour ..... do	7.05
Dry coal:	
Per indicated horsepower hour ..... do	4.88
Per electrical horsepower hour ..... do	6.03

BRIQUETTING TEST.

Illinois No. 7 E (slack).

Test 244†.—Size as used: Over ¼ inch, 1.5 per cent; $\frac{1}{10}$ inch to ¼ inch, 6.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 14.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 22.0 per cent; through $\frac{1}{40}$ inch, 55.7 per cent. Briquets with 8 per cent binder were satisfactory, were easily handled from the machine without breaking, and became very hard when cold; fracture was rough and edges easily crumbled, owing to excessive amount of clay present; outer surfaces smooth, with dull color. For analyses of briquets see top of this page.

Details of manufacture:		Drop test (1-inch screen):	
Machine used	Renf.	Held ..... per cent	63.5
Temperature of briquets ..... °F	167	Passed ..... do	36.5
Binder		Tumbler test (1-inch screen):	
Kind	w. g. p.	Held ..... do	87.5
Laboratory No. (see p. 40)	4806	Passed (fines) ..... do	12.5
Amount ..... per cent	8	Fines through 10-mesh sieve ..... do	97.2
Weight of—		Water absorption:	
Fuel briquetted ..... pounds	12,000	In 10 days ..... do	7.4
Briquets, average ..... do	0.472	Average for first 3 days ..... do	1.9
Heat value per pound—		Specific gravity (apparent)	1.257
Fuel as received ..... B. t. u.	8,797		
Fuel as fired ..... do	16,021		
Binder ..... do	16,864		

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 244†.
Laboratory No	4806	4760	4928
Air-drying loss, per cent		10.60	1.70
Extracted by CS_2:			
Air dried, do		.47	8.24
As received, do	96.90	.42	8.09
Pitch in briquets, as received, do			7.96

ILLINOIS NO. 9.[a]

Bituminous slack coal from a mine near Staunton was designated Illinois No. 9 C. One carload, shipped uninspected, was used in steaming tests (on briquets) 492 and 497 and briquetting tests 189, 190, 233, and 234†.

CHEMICAL ANALYSES.

Illinois No. 9 C.

	Car sample.	Steaming tests.[a]		Briquetting test 234†.[b]
		492.	497.	
Laboratory No	4247	4406	4473	4874
Air-drying loss	13.30		15.10	3.10
Proximate:				
Moisture	15.25	14.62	17.43	5.43
Volatile matter	28.57	32.38	28.98	33.55
Fixed carbon	40.83	39.13	39.99	47.63
Ash	15.35	13.87	13.60	13.39
Sulphur	3.81	3.51	3.30	3.52
Ultimate:				
Hydrogen	5.22	4.33	4.31	4.44
Carbon	53.95	65.67	66.29	68.44
Nitrogen	.82	.88	.99	.94
Oxygen	20.85	8.77	7.94	8.30
Ash		16.24	16.47	14.16
Sulphur		4.11	4.00	3.72
Calorific value (as received):				
Determined, calories	5,439		5,524	6,507
Determined, B. t. u.	9,790		9,943	11,713
Calculated from ultimate analysis, calories	5,344			
Calculated from ultimate analysis, B. t. u.	9,619			

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Illinois No. 9 C (English briquets).

	Test 492.	Test 497.
Duration of test, hours	10.00	9.38
Heating value of fuel, B. t. u. per pound dry fuel	12,037	12,042
Force of draft:		
Under stack damper, inch water	0.91	0.84
Above fire, do	.05	.18
In ash pit, do	.16	
Furnace temperature, °F		2,605
Dry fuel used per square foot of grate surface per hour, pounds	22.52	19.75
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.50	3.06
Percentage of rated horsepower of boiler developed	98.2	85.9
Water apparently evaporated per pound of fuel as fired, pounds	5.51	5.32
Water evaporated from and at 212° F.:		
Per pound of fuel as fired, do	6.65	6.42
Per pound of dry fuel, do	7.79	7.77
Per pound of combustible, do	9.37	9.49
Efficiency of boiler, including grate (item 73), per cent	62.50	62.31
Fuel as fired:		
Per indicated horsepower hour, pounds	4.25	4.40
Per electrical horsepower hour, do	5.25	5.44
Dry fuel:		
Per indicated horsepower hour, do	3.63	3.64
Per electrical horsepower hour, do	4.48	4.49

[a] For other tests of coal from this mine (Illinois No. 9 A and Illinois No. 9 B), made during 1905, see Bull. U. S. Geol. Survey No. 290, 1906, pp. 63-66.

Remarks.—Forced draft was used in test 492 (on English briquets made in test 189) and natural draft in test 497 (briquetting test 190). Briquets were burned whole in both tests, but did not burn well with natural draft; 4.3 per cent black smoke. Test 492 made 51 per cent clinker; test 497 made 36 per cent clinker.

BRIQUETTING TESTS.

Illinois No. 9 C (slack).

Tests 189, 190, 233, 234.—Size as used: Over $\frac{1}{4}$ inch, 0.4 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 3.9 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 14.4 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 25.1 per cent; through $\frac{1}{40}$ inch, 56.2 per cent. Briquets with 6 and 7 per cent binder were satisfactory, having hard surface but rough fracture without crumbling; outer surface of Renfrow briquets soft, although they stood handling from machine; fracture crumbly but briquets tough. This coal requires high pressure to make good briquets. For analyses of briquets see page 81 (briquets from test 189 under "Steaming test 492," from test 190 under "Steaming test 497").

	Test 189.	Test 190.	Test 233.	Test 234†.
Details of manufacture:				
Machine used	Eng.	Eng.	Renf.	Renf.
Temperature of briquets, °F.	167	167	149	149
Binder—				
Kind	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4543	4543	4806	4806
Amount, per cent.	6	7	8	9
Weight of—				
Fuel briquetted, pounds.	12,000	12,000	18,000	5,000
Briquets, average, do.	3.85	3.73	0.448	0.426
Heat value per pound—				
Fuel as received, B. t. u.	9,790	9,790	9,790	9,790
Fuel as fired, do.	10,276	9,943	(a)	11,713
Binder, do.	16,969	16,969	16,864	16,864
Drop test (1-inch screen):				
Held, per cent.	62.0	57.0	54.5	64.5
Passed, do.	38.0	43.0	45.5	35.5
Tumbler test (1-inch screen):				
Held, do.	77.2	76.2	87.5	88.5
Passed (fines), do.	22.8	23.8	12.5	11.5
Fines through 10-mesh sieve, do.	80.3	81.4	95.5	84.6
Weathering test:				
Time exposed, days.	6	6	.....	.....
Condition	B	B	.....	.....
Water absorption:				
In 19 days, per cent.	9.4	12.0	.....	.....
In 13 days, do.	.....	.....	10.2	9.1
Average for first 3 days, do.	1.67	2.03	2.43	2.17
Specific gravity (apparent)	1.146	1.124	1.098	1.128

(a) No test.

Extraction analyses.

	Pitches.		Fuel.	Briquets.		
				Test 189.	Test 190.	Test 234†.
Laboratory No.	4543	4806	4247	4406	4473	4874
Air-drying loss, per cent.	.....	.....	13.30	12.30	15.10	3.10
Extracted by CS_2:						
Air-dried, do.	.....	.....	.73	7.18	7.28	9.71
As received, do.	99.66	96.90	.63	6.30	6.18	9.41
Pitch in briquets, as received, do.	.....	.....	.....	5.75	5.50	9.12

ILLINOIS NO. 12.[a]

Bituminous coal from Bush, Williamson County, designated Illinois No. 12 B, was No. 5 washed, and this sample was shipped uninspected and used washed in steaming test 463 (on briquets) and briquetting tests 166*, 177*†, and 181*.

CHEMICAL ANALYSES.

Illinois No. 12 B.

	Car samples, washed.			Steaming test 463.[a]	Briquetting tests.[b]	
					177*†.	181*.
Laboratory No	4201	3907	4085	4228	.....	.....
Air-drying loss	13.30	9.00	12.40	.....	.....	.....
Proximate:						
Moisture	15.87	12.61	15.31	6.99	5.57	5.78
Volatile matter	28.19	30.08	28.93	32.36	32.38	32.62
Fixed carbon	46.42	46.81	45.29	50.24	50.96	49.80
Ash	9.52	10.50	10.47	10.41	11.09	11.80
Sulphur	2.34	2.37	2.32	2.41	2.41	2.58
Ultimate:						
Hydrogen	5.60	5.37	5.61	4.49	4.20	4.59
Carbon	59.66	62.15	59.88	72.03	70.09	71.48
Nitrogen	1.06	.93	1.04	1.09	1.11	1.09
Oxygen	21.82	18.68	20.68	8.61	10.28	7.57
Ash	.....	.....	.....	11.19	11.77	12.53
Sulphur	.....	.....	.....	2.59	2.55	2.74
Calorific value (as received):						
Determined (calories)	5,991	6,148	6,011	.....	.....	.....
Determined (B. t. u.)	10,784	11,066	10,820	.....	.....	.....
Calculated from ultimate analysis (calories)	5,862	6,119	5,932	.....	.....	.....
Calculated from ultimate analysis (B. t. u.)	10,552	11,014	10,693	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TEST.

Illinois No. 12 B (Renfrow briquets.)

	Test 463.
Duration of test, hours	10.03
Heating value of fuel, B. t. u. per pound dry fuel	12,859
Force of draft with reference to atmospheric pressure:	
Under stack damper, inch water	0.81
Above fire, do	.11
Furnace temperature, °F	2,490
Dry fuel used per square foot of grate surface per hour, pounds	18.67
Equivalent water evaporated per square foot of water-heating surface per hour, do	3.20
Percentage of rated horsepower of boiler developed	89.7
Water apparently evaporated per pound of fuel as fired, pounds	6.61
Water evaporated from and at 212 °F:	
Per pound of fuel as fired, do	7.98
Per pound of dry fuel, do	8.58
Per pound of combustible, do	9.84
Efficiency of boiler, including grate, per cent	64.44
Fuel as fired:	
Per indicated horsepower hour, pounds	3.54
Per electrical horsepower hour, do	4.37
Dry fuel:	
Per indicated horsepower hour, do	3.30
Per electrical horsepower hour, do	4.07

[a] For other tests of coal from this mine, made during 1905, see Bull. U. S. Geol. Survey No. 290, 1906, pp. 74-76.

Remarks.—Test 463 made on briquets from test 166*. Burned slowly with short flame and hot bed; 5 per cent black smoke; 41 per cent clinker, dark-gray color, stuck to grate. Ash contained fine unburned coal due to breaking up of fuel during combustion.

BRIQUETTING TESTS.

Illinois No. 12 B (washed).

Tests 166, 177*†, 181*.*—Size as shipped: No. 5. Size as used: Over ¼ inch, 0.2 per cent; $\frac{1}{10}$ inch to ¼ inch, 3.4 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 15.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 24.4 per cent; through $\frac{1}{40}$ inch, 56.8 per cent. For analyses of briquets see page 83. Analysis of briquets from test 166* given under "Steaming test 463." Excellent English briquets made with 6.25 per cent binder and Renfrow briquets with 7 per cent binder. Briquets easily handled when warm, although some difficulty was experienced in piling Renfrow briquets, which stuck together owing to low melting point of binder. Surfaces of all briquets were hard and smooth, with rough, clean fracture and sharp edges.

	Test 166*.	Test 177*†.	Test 181*.
Details of manufacture:			
Machine used	Renf.	Eng.	Renf.
Temperature of briquets ..... ° F.	131	185	131
Binder—			
Kind	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4120	4543	4543
Amount ..... per cent.	8	0.25	7
Weight of—			
Fuel briquetted ..... pounds.	100,000	51,000	53,000
Briquets, average ..... do.	0.463	3.66	0.432
Heat value per pound—			
Fuel as received ..... B. t. u.	10,784	10,784	10,784
Fuel as fired ..... do.	11,961	12,155	12,076
Binder ..... do.	17,060	16,969	16,969
Drop test (1-inch screen):			
Held ..... per cent.	66.5	85.1	65.5
Passed ..... do.	33.3	14.9	34.5
Tumbler test (1-inch screen):			
Held ..... do.	83.5	84.5	84.0
Passed (fines) ..... do.	16.5	15.5	16.0
Fines through 10-mesh sieve ..... do.	96.5	78.3	96.0
Weathering test:			
Time exposed ..... days.	63	12	19
Condition	B.	A.	B.
Water absorption:			
In 19 days ..... per cent.	13.3	8.5	15.0
Average for first 4 days ..... do.	2.15	1.00	2.13
Specific gravity (apparent)	1.074	1.101	1.041

Extraction analyses.

	Pitches.		Fuel.	Briquets.		
				Test 166*.	Test 177*†.	Test 181*.
Laboratory No.	4120	4543	4201	4228	.....	.....
Air-drying loss ..... per cent.	.....	.....	13.30	4.10	.....	.....
Extracted by CS_2:						
Air dried ..... do.	.....	.....	.....	6.54	.....	.....
As received ..... do.	97.70	99.66	.02	6.27	6.35	6.05
Pitch in briquets, as received ..... do.	.....	.....	.....	6.40	6.35	6.05

ILLINOIS NO. 19.[a]

Bituminous coal from bed No. 7 at Zeigler, Franklin County, was designated Illinois No. 19. The coal, as worked at a depth of 420 feet at this place, averages 6 feet 9 inches in thickness.

Three samples were shipped under the supervision of John W. Groves, as follows: Illinois No. 19 C consisted of run-of-mine coal, and was used in steaming tests 420 and 423 and producer-gas tests 128. Illinois No. 19 D consisted of lump coal over a 6-inch shaking screen and was used in steaming tests 424 and 425. Illinois No. 19 E consisted of screenings through a 1½-inch shaking screen and was used in steaming tests 421 and 422.

One mine sample (No. 3408) was taken for chemical analysis 1,500 feet southwest of the shaft, where the coal measured 11 feet 2 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 19.

	Mine sample.	Steaming tests.[a]					
		C.		D.		E.	
		420.	423.	424.	425.	421.	422.
Laboratory No	3408						
Proximate:							
Moisture	9.65	8.72	9.42	8.45	8.51	9.22	9.75
Volatile matter	30.87	28.41	28.05	29.65	30.27	29.28	28.45
Fixed carbon	53.23	50.58	50.72	50.24	49.85	50.25	50.67
Ash	6.25	12.29	11.81	11.66	11.37	11.25	11.13
Sulphur	.45	.63	.61	.53	.51	.59	.61
Ultimate:							
Hydrogen		4.64	4.67	4.12	4.13	4.13	4.13
Carbon		71.08	71.44	70.23	70.51	70.47	71.48
Nitrogen		1.56	1.57	1.59	1.60	1.60	1.58
Oxygen		8.57	8.61	10.74	10.77	10.76	9.80
Ash		13.46	13.04	12.74	12.43	12.39	12.33
Sulphur		.69	.67	.58	.56	.65	.68

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Illinois No. 19.

	C.		D.		E.	
	Test 420.	Test 423.	Test 424.	Test 425.	Test 421.	Test 422.
Size as shipped	r. o. m.	r. o. m.	No. 6 lump.	No. 6 lump.	No. 2 nut.	No. 2 nut.
Size as used:						
Over 1 inch....per cent..	20.2	15.8	23.9	37.9	18.0	14.4
½ inch to 1 inch....do....	24.2	19.5	24.5	27.4	45.9	44.0
¼ inch to ½ inch....do....	19.1	18.3	18.7	15.0	16.6	17.8
Under ¼ inch....do....	36.5	46.4	32.9	19.7	19.5	23.8
Average diameter....inch..	0.66	0.57	0.71	0.91	0.78	0.72
Duration of test....hours..	10.03	10.03	10.0	10.00	10.0	10.07
Heating value of coal, B. t. u. per pound dry coal	12,431	12,496	12,416	12,460	12,454	12,578
Force of draft:						
Under stack damper....inch water..	0.65	0.59	0.64	0.65	0.66	0.62
Above fire....do....	.12	.14	.12	.14	.11	.12

[a] For other tests of coal from this mine, made during 1905, see Bull. U. S. Geol. Survey No. 290, 1906, pp. 91-94.

STEAMING TESTS—Continued.

Illinois No. 19.

	C.		D.		E.	
	Test 420.	Test 423.	Test 424.	Test 425.	Test 421.	Test 422.
Dry coal used per square foot of grate surface per hour ..... pounds....	19.95	16.94	18.67	19.33	19.46	19.46
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	3.35	2.89	3.18	3.32	3.30	3.39
Percentage of rated horsepower of boiler developed.....	93.9	81.0	89.1	93.0	92.5	95.0
Water apparently evaporated per pound of coal as fired..... pounds..	6.61	6.66	6.73	6.79	6.63	6.78
Water evaporated from and at 212° F.:						
Per pound of coal as fired... pounds..	7.67	7.73	7.81	7.87	7.70	7.88
Per pound of dry coal..... do....	8.40	8.53	8.53	8.61	8.48	8.73
Per pound of combustible ..... do....	10.00	10.12	10.00	10.09	9.93	10.20
Efficiency of boiler, including grate, per cent.....	65.26	65.92	66.35	66.73	65.76	67.03
Coal as fired:						
Per indicated horsepower hour, pounds.....	3.69	3.66	3.62	3.59	3.67	3.59
Per electrical horsepower hour, pounds.....	4.55	4.52	4.47	4.44	4.53	4.43
Dry coal:						
Per indicated horsepower hour, pounds.....	3.37	3.32	3.32	3.28	3.33	3.24
Per electrical horsepower hour, pounds.....	4.16	4.09	4.09	4.05	4.12	4.00

PRODUCER-GAS TEST.

Illinois No. 19 C (run of mine).

Test 128.—Duration of test, 50 hours; average electrical horsepower, 141.0; average B. t. u. per cubic foot of gas, 137.8; total coal fired, 14,400 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available.....	2.20	1.98	1.76
Developed at switchboard.....	2.04	1.84	1.64
Per brake horsepower:			
Commercially available.....	1.87	1.68	1.49
Developed at engine.....	1.74	1.57	1.39
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available.....	2.40	2.16	1.92
Developed at switchboard.....	2.23	2.01	1.78
Per brake horespower:			
Commercially available.....	2.04	1.84	1.63
Developed at engine.....	1.90	1.71	1.52

Analyses.

Coal.		*Gas by volume.*	
Moisture.....	9.82	Carbon dioxide (CO_2).....	11.6
Volatile matter.....	29.64	Carbon monoxide (CO).....	16.8
Fixed carbon.....	50.34	Hydrogen (H_2).....	16.5
Ash.....	10.20	Methane (CH_4).....	1.9
Sulphur.....	.49	Nitrogen (N_2).....	52.9
		Ethylene (C_2H_4).....	.3

ILLINOIS NO. 20.

Bituminous coal from Staunton, Macoupin County, on the Litchfield and Madison Railroad, was designated Illinois No. 20.

This sample consisted of screenings, and was shipped by the operator, primarily for washing tests. It was used in steaming tests (washed coal) 292, 301, and 302; washing test 142; coking tests 106 (raw) and 107 (washed); and mixed with Kentucky No. 2 B (coke breeze, see p. 159) in briquetting tests 103 and 104.

CHEMICAL ANALYSES.

Illinois No. 20.

	Car sample.	Steaming tests.[a]		
		292.	301.	302.
Laboratory No.	2731	.....	.....	.....
Air-drying loss	12.40	.....	.....	.....
Proximate:				
Moisture	14.68	14.52	16.51	16.36
Volatile matter	31.32	31.98	32.17	33.54
Fixed carbon	40.32	38.01	40.87	39.84
Ash	13.68	15.49	10.45	10.26
Sulphur	3.88	4.32	3.25	3.22
Ultimate:				
Hydrogen	5.41	4.28	4.66	4.68
Carbon	55.21	62.59	68.11	68.34
Nitrogen	1.00	1.14	1.23	1.23
Oxygen	20.82	8.82	9.60	9.63
Ash	.....	18.12	12.51	12.27
Sulphur	.....	5.05	3.89	3.85
Calorific value (as received):				
Determined, calories	5,585	.....	.....	.....
Determined, B. t. u.	10,053	.....	.....	.....
Calculated from ultimate analysis, calories	5,517	.....	.....	.....
Calculated from ultimate analysis, B. t. u.	9,931	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Illinois No. 20 (washed screenings).

	Test 292.	Test 301.	Test 302.
Size as used:			
Over 1 inch, per cent	20.1	17.1	22.5
½ inch to 1 inch, do	22.9	27.7	28.1
¼ inch to ½ inch, do	18.7	23.7	21.9
Under ¼ inch, do	38.3	31.5	27.5
Duration of test, hours	9.8	9.95	9.02
Kind of grate	.....	Rocking.	Rocking.
Heating value of coal, B. t. u. per pound dry coal	11,425	12,506	12,548
Force of draft:			
Under stack damper, inch water	0.53	0.57	0.53
Above fire, do	.10	.30	.17
Furnace temperature, °F.	2,020	.....	2,708
Dry coal used per square foot of grate surface per hour, pounds	15.49	24.61	25.69
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	2.37	3.54	3.81
Percentage of rated horsepower of boiler developed	66.3	99.3	106.7
Water apparently evaporated per pound of coal as fired, pounds	5.47	5.57	5.74
Water evaporated from and at 212° F.:			
Per pound of coal as fired, do	6.55	6.71	6.91
Per pound of dry coal, do	7.66	8.04	8.27
Per pound of combustible, do	9.61	9.43	9.57
Efficiency of boiler, including grate, per cent	64.75	62.08	63.65
Coal as fired:			
Per indicated horsepower hour, pounds	4.32	4.22	4.09
Per electrical horsepower hour, do	5.33	5.20	5.05
Dry coal:			
Per indicated horsepower hour, do	3.69	3.52	3.42
Per electrical horsepower hour, do	4.56	4.34	4.22

WASHING AND COKING TESTS.

Illinois No. 20 (screenings).

Washing test 142.—Jig used, Stewart. Raw coal, 63,280 pounds: washed, 57,000 pounds; refuse, 6,280 pounds.

Coking tests.

		Test 106 (raw).	Test 107 (w.)
Size as used		f. c.	f. c.
Duration of test	hours.	47	36
Coal charged	pounds.	10,000	10,000
Coke produced	do.	4,255	4,659
	per cent.	42.55	46.59
Breeze produced	pounds.	628	398
	per cent.	6.28	3.98
Total yield	do.	48.83	50.57

Remarks.—Test 106: Dull-gray color; dense; cross fracture of coke bad; ash and sulphur very high. Test 107: Dull-gray color; a little deposited carbon; ash and sulphur not materially reduced by washing; physically better than coke from raw coal; percentage of breeze shows large reduction.

Analyses.

	Washing test 142.		Coking test 106.		Coking test 107.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	14.68	16.80	17.04	0.57	14.36	0.53
Volatile matter	31.32	.....	32.59	.66	34.61	.29
Fixed carbon	40.32	.....	40.77	82.49	42.63	84.87
Ash	13.68	10.26	9.60	16.28	8.40	14.31
Sulphur	3.88	3.21	3.23	3.01	3.23	2.73

BRIQUETTING TESTS.

Illinois No. 20 mixed with Kentucky No. 2 B.

Tests 103, 104.—Size as shipped, breeze through 1-inch coke fork and coal screenings. Machine used, English. Temperature of briquets, 179.6° F. Kind of binder, coal-tar pitch. Amount of binder, 6 per cent. The flowing point of the binder used (laboratory No. 2729) was 255° F., and 61.2 per cent of the sample as received was extracted by CS_2. All other data concerning this binder were lost in the fire. Weight of fuel briquetted, 2,000 pounds.

Briquets made from coke breeze with 20 per cent, 33⅓ per cent, and 47 per cent coal, using 6 per cent pitch, were easily broken in handling; coke breeze was washed, one-half used wet and one-half put through drier. Briquets made with dried fuel handled better when hot, but there was no difference in the two briquets when cold. Washed breeze was too high in ash for satisfactory fuel.

These briquets were used in a preliminary test in switching locomotives. Briquets with 20 per cent coal burned too slowly for switching service. Briquets with 33⅓ per cent coal were satisfactory for switching, but burned too slowly for freight or passenger service. Briquets with 47 per cent coal were satisfactory for all services.

ILLINOIS NO. 21.

Bituminous coal from Troy, Madison County, on the St. Louis, Troy and Eastern Railroad, was designated Illinois No. 21. The coal as worked at a depth of 275 feet at this place averages 5 feet in thickness.

This sample which was taken under the inspection of John W. Groves, consisted of lump coal over a 2¼-inch screen. Five 40-ton cars were shipped to the testing plant, three of which were sent for an endurance test on the producer and the other two for a complete series of tests, as follows: Steaming tests 315 and 316 (washed coal) and 318 (on briquets), producer-gas test 105, washing test 160, coking tests 126 and 137 (washed coal), and briquetting test 113.

Two mine samples were taken for chemical analysis. Sample 2771 was cut 800 feet northwest of the bottom of the shaft, where the coal measured 5 feet 8 inches in thickness. Sample 2770 was cut 1,500 feet southeast of the bottom of the shaft, where the coal measured 4 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 21.

	Mine samples.		Car samples.		Steaming tests.[a]		
					315.	316.	318.
Laboratory No.	2770	2771	2852	2920			
Air-drying loss	10.50	13.30	10.40	8.20			
Proximate:							
Moisture	15.23	17.79	15.54	15.30	14.95	15.07	17.31
Volatile matter	31.42	28.78	31.26	30.59	30.33	30.78	30.40
Fixed carbon	44.32	42.34	42.27	43.40	40.96	41.90	42.28
Ash	9.03	11.09	10.93	10.71	13.76	12.25	10.01
Sulphur	1.59	1.40	1.38	1.43	1.60	1.27	1.28
Ultimate:							
Hydrogen			5.59		4.39	4.50	4.41
Carbon			58.02		65.89	67.62	70.01
Nitrogen			1.09		1.23	1.27	1.32
Oxygen			22.99		10.43	10.69	10.61
Ash					16.18	14.42	12.10
Sulphur					1.88	1.50	1.55
Calorific value (as received):							
Determined—calories	6,056		5,837				
Determined—B. t. u.	10,901		10,507				
Calculated from ultimate analysis—calories			5,655				
Calculated from ultimate analysis—B. t. u.			10,179				

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Illinois No. 21 (lump).

	Test 315.	Test 316.	Test 318.
Size as used:			
Over 1 inch, per cent	34.0	33.6	(a)
½ inch to 1 inch, do	21.3	20.6	
¼ inch to ½ inch, do	18.1	16.2	
Under ¼ inch, do	26.6	29.6	

[a] On briquets which were broken in two. The fuel cracked to center into coke fragments and held together until consumed. Percentage of clinker large.

STEAMING TESTS—Continued.

Illinois No. 21 (lump).

	Test 315.	Test 316.	Test 318.
Duration of test.....hours..	[a] 4.88	10.03	7.3
Heating value of fuel.....B. t. u. per pound dry fuel..	11,945	12,240	12,469
Force of draft:			
Under stack damper.....inch water..	0.63	0.59	0.76
Above fire.....do....	.16	.15	.04
Furnace temperature.....°F..	2,499	2,401	2,508
Dry fuel used per square foot of grate surface per hour.....pounds..	20.05	20.05	25.30
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.27	3.19	4.11
Percentage of rated horsepower of boiler developed.....	91.6	89.3	115.3
Water apparently evaporated per pound of fuel as fired.....pounds..	5.76	5.67	5.6
Water evaporated from and at 212° F.:			
Per pound of fuel as fired.....do....	6.94	6.76	6.73
Per pound of dry fuel.....do....	8.16	7.96	8.14
Per pound of combustible.....do....	9.95	9.53	9.40
Efficiency of boiler, including grate.....per cent..	65.97	62.80	63.04
Fuel as fired:			
Per indicated horsepower hour.....pounds..	4.07	4.18	4.20
Per electrical horsepower hour.....do....	5.03	5.16	5.19
Dry coal:			
Per indicated horsepower hour.....do....	3.46	3.55	3.47
Per electrical horsepower hour.....do....	4.28	4.39	4.29

[a] Too short for reliable results.

PRODUCER-GAS TEST.

Illinois No. 21 (lump).

Test 105.—Duration of test,[a] 562 hours; average electrical horsepower, 191.7; average B. t. u. per cubic foot of gas, 156.1; total coal fired, 208,350 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available.....	2.04	1.74	1.50
Developed at switchboard.....	1.93	1.65	1.43
Per brake horsepower:			
Commercially available.....	1.73	1.47	1.28
Developed at engine.....	1.64	1.40	1.22
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available.....	2.18	1.86	1.61
Developed at switchboard.....	2.07	1.77	1.53
Per brake horsepower:			
Commercially available.....	1.85	1.58	1.37
Developed at engine.....	1.76	1.50	1.30

Analyses.

Coal.		*Gas by volume.*	
Moisture.....	14.68	Carbon dioxide (CO_2).....	9.2
Volatile matter.....	30.98	Carbon monoxide (CO).....	20.9
Fixed carbon.....	42.93	Hydrogen (H_2).....	15.6
Ash.....	11.41	Methane (CH_4).....	1.9
Sulphur.....	1.33	Nitrogen (N_2).....	52.0
		Ethylene (C_2H_4).....	.4

[a] See p. 26.

WASHING AND COKING TESTS.

Illinois No. 21 (lump).

Washing test 160.—Size as used, crushed to 2 inches. Jig used, Stewart. Raw coal, 17,000 pounds; washed, 14,640 pounds; refuse, 2,360 pounds.

Coking tests.

	Test 126 (raw).	Test 137 (washed).
Size as used	f. c.	f. c.
Duration of test.....hours..	44	45
Coal charged.....pounds..	12,000	11,690
Coke produced	None.	None.

Remarks.—Test 137: Product a mixture of unburned coal and slightly coherent mass of coal of original size, showing no trace of cell structure. All volatile expelled.

Analyses.

	Washing test 160.		Coking test 126 (coal).	Coking test 137 (coal).
	Raw coal.	Washed coal.		
Moisture	15.30	8.25	13.37	17.45
Volatile matter	30.59	.....	31.17	30.01
Fixed carbon	43.40	.....	43.15	44.74
Ash	10.71	8.09	12.31	7.80
Sulphur	1.43	1.25	1.46	1.10

BRIQUETTING TEST.

Illinois No. 21 (lump).

Test 113.—Machine used, English; temperature of briquets, 179.6° F.; kind of binder, coal-tar pitch; laboratory No. 2933 (see p. 40); amount of binder, 5 and 6 per cent; weight of fuel briquetted, 14,000 pounds. B. t. u. per pound of coal as received, 12,440; per pound of briquets as fired, 12,469; per pound of binder, 15,937. Briquets made with 5 per cent binder were hard and firm, and stood rough handling. Weathering test: Days' exposure, 75; condition of briquets made with 5 per cent binder, B.

ILLINOIS NO. 22.

Bituminous coal from Maryville, Madison County, on the St. Louis, Troy and Eastern Railroad, was designated Illinois No. 22. The coal, as worked at a depth of 260 feet at this place, averages 7 feet 6 inches in thickness.

Two lots of coal were shipped from this locality under the supervision of John W. Groves. The first lot, Illinois No. 22 A, consisted of lump coal over a 4-inch perforated shaker screen. It was used in making steaming tests 324 (raw), 325 (raw), and 328 (washed); producer-gas test 102; and washing test 151. The second lot, Illinois No. 22 B, consisted of nut, pea, and slack coal which was screened through a 2-inch perforated screen. It was used in making washing test 150; coking tests 117 (raw) and 118 (washed); and cupola test 125.

Two mine samples were taken for chemical analysis. Sample 2772 was cut 300 feet south of the bottom of the shaft, where the coal measured 8 feet 2 inches in thickness. Sample 2773 was taken 2,500 feet north of the bottom of the shaft, where the coal measured 7 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 22.

	Mine samples.		Car samples.		Steaming tests.[a]		
			A.	B.	324.	325.	328.
Laboratory No	2772	2773	2905	2896			
Air-drying loss	9.20	9.90	5.90	11.20			
Proximate:							
Moisture	13.51	13.83	11.91	13.03	11.50	10.53	14.35
Volatile matter	34.64	34.16	35.65	32.65	33.44	35.63	36.86
Fixed carbon	41.70	42.24	39.43	39.79	39.27	40.04	40.57
Ash	10.15	9.77	13.01	14.53	15.79	13.80	8.22
Sulphur	4.01	4.10	5.34	4.35	6.24	6.07	3.75
Ultimate:							
Hydrogen			5.21	5.25	4.18	4.33	4.79
Carbon			57.35	55.94	61.77	63.97	70.73
Nitrogen			1.00	.89	1.07	1.12	1.23
Oxygen			18.09	19.04	8.09	8.37	9.27
Ash					17.84	15.43	9.60
Sulphur					7.05	6.78	4.38
Calorific value (as received):							
Determined... calories	6,045		5,897	5,662			
Determined... B. t. u.	10,881		10,615	10,192			
Calculated from ultimate analysis... calories			5,771	5,607			
Calculated from ultimate analysis... B. t. u.			10,388	10,093			

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Illinois No. 22 A (lump).

	Test 324 (raw).	Test 325 (raw).	Test 328 (washed)
Size as used:			
Over 1 inch ... per cent	84.6	87.4	34.1
½ inch to 1 inch ... do	5.8	5.4	27.0
¼ inch to ½ inch ... do	3.5	6.2	22.0
Under ¼ inch ... do	6.1	4.6	16.9
Average diameter ... inches	.4	4	
Duration of test ... hours	9.93	10	9.9
Heating value of coal ... B. t. u. per pound dry coal	11,484	11,876	12,924
Force of draft:			
Under stack damper ... inch water	0.59	0.54	0.78
Above fire ... do	.20	.18	.14
Furnace temperature ... °F.	2,850	2,828	2,829
Dry coal used per square foot of grate surface per hour ... pounds	23.08	22.61	26.73
Equivalent water evaporated per square foot of water-heating surface per hour ... pounds	3.60	3.60	4.34
Percentage of rated horsepower of boiler developed	100.9	101.0	121.8
Water apparently evaporated per pound of coal as fired ... pounds	5.78	5.92	5.78
Water evaporated from and at 212° F.:			
Per pound of coal as fired ... pounds	6.91	7.14	6.97
Per pound of dry coal ... do	7.81	7.97	8.14
Per pound of combustible ... do	9.70	9.61	9.16
Efficiency of boiler, including grate ... per cent	65.67	64.81	60.82
Coal as fired:			
Per indicated horsepower hour ... pounds	4.09	3.96	4.06
Per electrical horsepower hour ... do	5.05	4.89	5.01
Dry coal:			
Per indicated horsepower hour ... do	3.62	3.55	3.47
Per electrical horsepower hour ... do	4.47	4.38	4.29

PRODUCER-GAS TEST.

Illinois No. 22 A (lump).

Test 102.—Duration of test, 47 hours; average electrical horsepower, 196.5; average B. t. u. per cubic foot of gas, 159.6; total coal fired, 16,300 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.88	1.67	1.42
Developed at switchboard	1.77	1.57	1.33
Per brake horsepower:			
Commercially available	1.60	1.42	1.21
Developed at engine	1.50	1.33	1.13
Equivalent used by producer plant.			
Per electrical horsepower:			
Commercially available	2.09	1.77	1.51
Developed at switchboard	1.88	1.66	1.42
Per brake horsepower			
Commercially available	1.70	1.51	1.28
Developed at engine	1.59	1.41	1.20

Analyses.

Coal.		*Gas by volume.*	
Moisture	11.29	Carbon dioxide (CO_2)	9.4
Volatile matter	35.60	Carbon monoxide (CO)	20.2
Fixed carbon	39.94	Hydrogen (H_2)	13.7
Ash	13.17	Methane (CH_4)	2.0
Sulphur	4.88	Nitrogen (N_4)	54.0
		Ethylene (C_2H_4)	.7

WASHING AND COKING TESTS.

Illinois No. 22.

Washing tests.

	Test 151 (A).	Test 150 (B).		Test 151 (A).	Test 150 (B).
Size as shipped	l.	sc.	Raw coal, pounds	19,400	40,000
Size as used	cr. to 2"	sc.	Washed coal, do	17,000	32,000
Jig used	Stewart.	Stewart.	Refuse, do	2,400	8,000

Coking tests (B).

	Test 117 (raw).	Test 118 (washed).
Size as shipped	sc.	sc.
Size as used	f. c.	f. c.
Duration of test, hours	45	76
Coal charged, pounds	10,000	12,000
Coke produced, do	5,046	5,616
Coke produced, per cent	50.46	46.80
Breeze produced, pounds	534	574
Breeze produced, per cent	5.34	4.78
Total yield, do	55.80	51.58

Remarks.—Test 117: Dull-gray color; breakage very irregular, due to high percentage of slate; ash and sulphur high; poor coke. Test 118: Light-gray color, with heavy black butt due to necessity of closing draft after 24 hours. Charge held in oven 148 hours. Ash reduced by washing. Will probably make fair coke under proper conditions.

Analyses.

	Washing test 151 (A).		Washing test 150 (B).		Coking test 117 (B).		Coking test 118 (B).	
	Raw coal.	Washed coal.	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	11.91	14.02	13.03	16.78	11.98	0.98	16.19	0.65
Volatile matter	35.65	.....	32.65	.....	33.87	.72	34.14	1.60
Fixed carbon	39.43	.....	39.79	.....	37.72	72.18	39.53	80.76
Ash	13.01	8.58	14.53	9.99	16.43	26.12	10.14	16.99
Sulphur	5.34	3.69	4.35	3.79	4.74	4.61	3.79	3.65

Cupola test of coke made from Illinois No. 22 B coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Coke.[a] Specific gravity.	Coke.[a] Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
125	118	1.84	1 to 7	98.61	Coke	210	55	55	55	55	430
					Pig iron	630	405	405	405	405	2,250
					Scrap	210	135	135	135	135	750

[a] Sulphur in ash, 0.05 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
125	3.04 p. m.	7	8	1,191	325	1,516	34	2,675	3.92	6.80	1,280	43

LADLE RECORD.

Ladle No.	Test 125. Pounds.	Test 125. Time (p. m.).	Ladle No.	Test 125. Pounds.	Test 125. Time (p. m.).
1	80	3.20	10	79	3.33
2	74	3.20½	11	60	3.38
3	96	3.23	12	68	3.38½
4	81	3.24	13	105	3.39
5	94	3.26	14	29	3.39½
6	62	3.26½	15	92	3.44
7	62	3.31	16	24	3.45
8	74	3.32	17	33	3.46
9	78	3.32½			

Remarks.—Test 125: Iron hot.

ILLINOIS NO. 23.

Bituminous coal from Donkville, Madison County, on the St. Louis, Troy and Eastern Railroad, was designated Illinois No. 23. The coal, as worked at a depth of 145 feet at this place, averages 6 feet in thickness.

This sample consisted of two lots of coal and was shipped under the supervision of John W. Groves. Illinois No. 23 A consisted of "superior lump" over a 5-inch perforated screen, and was used in steaming tests 306 (raw) and 317 (washed); producer-gas test 98;

washing test 146; and coking test 111. Illinois No. 23 B consisted of slack coal through a 2-inch perforated screen, and was used in steaming tests (on briquets) 321 and 322; producer-gas test 100; washing test 147; coking tests 112 and 114, both on washed coal; and briquetting test 116.

Two mine samples were taken for chemical analysis. Sample 2774 was cut 3,800 feet northeast of the shaft, where the coal measured 6 feet 1 inch in thickness. Sample 2775 was cut 4,000 feet northwest of the shaft, where the coal measured 6 feet 2 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 23.

	Mine samples.		Car samples.		Steaming tests.[a]		
			A.	B.	306.	317.	321 and 322.
Laboratory No.	2774	2775	2819	2803			
Air-drying loss	8.90	9.70	11.50	13.20			
Proximate:							
Moisture	13.07	12.79	13.47	15.68	14.49	14.64	13.54
Volatile matter	34.85	35.67	34.35	31.28	32.37	35.72	36.33
Fixed carbon	42.02	40.25	40.65	37.45	39.69	40.76	41.67
Ash	10.06	11.29	11.53	15.59	13.45	8.88	8.41
Sulphur	3.59	3.94	4.41	3.98	4.62	3.23	3.21
Ultimate:							
Hydrogen			5.63	5.42	4.62	5.03	4.86
Carbon			57.61	52.89	64.36	70.04	69.30
Nitrogen			.91	.90	1.02	1.10	1.14
Oxygen			19.91	21.22	8.87	9.65	11.26
Ash					15.73	10.40	9.73
Sulphur					5.40	3.78	3.71
Calorific value (as received):							
Determined—calories	6,083		5,839	5,364			
Determined—B. t. u.	10,949		10,510	9,655			
Calculated from ultimate analysis—calories			5,836	5,317			
Calculated from ultimate analysis—B. t. u.			10,505	9,571			

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Illinois No. 23.

	A (lump).		B (slack).	
	Test 306.	Test 317 (w).	Test 321.	Test 322.
Size as used:				
Over 1 inch—per cent	37.3	18.9	See p. 96	See p. 96.
½ inch to 1 inch—do	19.5	26.7		
¼ inch to ½ inch—do	16.2	24.3		
Under ¼ inch—do	27.0	30.1		
Duration of test—hours	9.4	8.12	4.4	3.65
Heating value of fuel—B. t. u. per pound of dry fuel	11,759	12,794	12,996	12,996
Force of draft:				
Under stack damper—inch water	0.46	0.55	0.75	0.65
Above fire—do	.13	.13	.27	.16
Furnace temperature—°F	2,402	2,397		
Dry fuel used per square foot of grate surface per hour—pounds	18.50	19.63	23.75	24.54
Equivalent water evaporated per square foot of water-heating surface per hour—pounds	3.01	3.23	3.78	3.80
Percentage of rated horsepower of boiler developed	84.3	90.4	106.0	106.6
Water apparently evaporated per pound of fuel as fired, pounds	5.80	5.89	5.72	5.62
Water evaporated from and at 212° F.:				
Per pound of fuel as fired—pounds	6.97	7.02	6.89	6.71
Per pound of dry fuel—do	8.15	8.23	7.97	7.76
Per pound of combustible—do	9.87	9.31	8.92	8.68
Efficiency of boiler, including grate—per cent	66.93	62.12	59.22	57.66
Fuel as fired:				
Per indicated horsepower hour—pounds	4.06	4.03	4.10	4.21
Per electrical horsepower hour—do	5.01	4.97	5.07	5.20
Dry coal:				
Per indicated horsepower hour—do	3.47	3.44	3.55	3.64
Per electrical horsepower hour—do	4.29	4.24	4.38	4.50

Remarks.—Tests 321 and 322 on briquets which were broken in two. They burned freely and quickly, giving a long flame and small percentage of smoke, coking and holding together well. No ash and very small amount of clinker.

PRODUCER-GAS TESTS.

Illinois No. 23.

	Test 98 (A).	Test 100 (B, w.).
Size as shipped	5-inch lump.	s.
Size as used:		
Over 1 inch, per cent	81	34
½ inch to 1 inch, do	3	24
¼ inch to ½ inch, do	4	20
Under ¼ inch, do	12	22
Duration of test, hours	50	50
Average electrical horsepower	198.3	181.5
Average B. t. u. per cubic foot of gas	147.9	145.0
Total coal fired, pounds	18,000	17,250

	Test 98.			Test 100.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).						
Per electrical horsepower:						
Commercially available	1.91	1.69	1.46	2.00	1.70	1.52
Developed at switch board	1.82	1.60	1.38	1.90	1.62	1.45
Per brake horsepower:						
Commercially available	1.63	1.43	1.24	1.70	1.45	1.29
Developed at engine	1.54	1.36	1.18	1.62	1.38	1.23
Equivalent used by producer plant (pounds).						
Per electrical horsepower:						
Commercially available	2.02	1.78	1.54	2.17	1.85	1.66
Developed at switch board	1.91	1.69	1.46	2.07	1.76	1.57
Per brake horsepower:						
Commercially available	1.71	1.51	1.31	1.85	1.57	1.41
Developed at engine	1.63	1.43	1.24	1.76	1.50	1.34

Analyses.

	Test 98.	Test 100.		Test 98.	Test 100.
Coal.			*Gas by volume.*		
Moisture	11.87	14.77	Carbon dioxide (CO_2)	8.4	10.9
Volatile matter	36.37	35.23	Carbon monoxide (CO)	20.9	17.2
Fixed carbon	39.87	40.98	Hydrogen (H_2)	12.9	13.8
Ash	11.89	9.02	Methane (CH_4)	1.6	2.1
Sulphur	4.65	3.46	Nitrogen (N_2)	55.7	55.3
			Ethylene (C_2H_4)	.5	.7

WASHING AND COKING TESTS.

Illinois No. 23.

Washing tests.

	Test 146 (A).	Test 147 (B).		Test 146 (A).	Test 147 (B).
Size as shipped	5-inch lump.	s.	Jig used	Stewart.	Stewart.
			Raw coal, pounds	28,000	80,000
Size as used	Crushed to 2-inch.	s.	Washed coal, do	24,000	63,000
			Refuse, do	4,000	17,000

Coking tests (on washed coal).

	A.	B.	
	Test 111.	Test 112.	Test 114.
Size as shipped	l.	s.	s.
Size as used	f. c.	f. c.	f. c.
Duration of test, hours	39	43	72
Coal charged, pounds	10,000	10,000	14,000
Coke produced, do	4,211	4,407	6,443
Coke produced, per cent	42.11	44.07	46.02
Breeze produced, pounds	347	389	601
Breeze produced, per cent	3.47	3.89	4.29
Total yield, do	45.58	47.96	50.31

Remarks.—Tests 111 and 112: Good heavy coke; light gray and silvery; ash and sulphur high. Test 114: Light gray and silvery, not as good as coke from smaller charge (test 112); ash and sulphur high.

Analyses.

	Washing test 146 (A).		Washing test 147 (B).		Coking test 111 (A).		Coking test 112 (B).		Coking test 114 (B).	
	Raw coal.	Washed coal.	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	13.47	13.81	15.68	16.83	13.74	0.66	15.85	0.96	15.93	1.36
Volatile matter	34.35	.....	31.28	.....	36.47	0.74	35.02	1.14	35.88	1.19
Fixed carbon	40.65	.....	37.45	.....	41.01	83.45	40.57	82.66	40.16	82.83
Ash	11.53	8.78	15.59	8.75	8.78	15.15	8.56	15.24	8.03	14.62
Sulphur	4.41	3.54	3.98	3.22	3.57	3.09	3.27	2.87	3.25	2.84

BRIQUETTING TEST.

Illinois No. 23 B (slack).

Test 116.—Size as shipped, through 2½-inch round shaker screen. Machine used, English. Temperature of briquets, 179.6° F. Kind of binder, coal-tar pitch; laboratory No. 2933 (see p. 40). Amount of binder, 5, 6, and 6.5 per cent. Weight of coal briquetted, 12,000 pounds. B. t. u. per pound of coal as received, 11,450; per pound of briquets as fired, 12,996; per pound of binder, 15,937. For analyses of briquets see page 95 (steaming tests 321 and 322).

Briquets made with 5 and 6 per cent binder broke up in handling. Those made with 6.5 per cent were satisfactory. In the weathering test all binders were exposed seventy days; condition of the 5 per cent D, of the 6 per cent C, of the 6.5 per cent B.

ILLINOIS NO. 24.

Bituminous coal from New Baden, Clinton County, on the Southern Railway, was designated Illinois No. 24. The coal, as worked at a depth of 320 feet at this place, averages 7 feet 6 inches in thickness.

Two lots of coal were shipped under the supervision of W. J. Von Borries, as follows: Illinois No. 24 A consisted of screenings which had passed through a 2½-inch shaking screen, and was used in washing test 169 and coking tests 119 and 155. Illinois No. 24 B consisted of lump coal over a 5½-inch bar screen, and was used in steaming tests 335, 336, and 337; producer-gas test 103; washing test 166; and coking test 145.

Two mine samples were taken for chemical analysis. Sample 2854 was cut 400 feet northwest of the shaft, where the coal measured 7 feet 8 inches in thickness. Sample 2855 was cut 600 feet northeast of the shaft, where the coal measured 8 feet in thickness.

CHEMICAL ANALYSES.

Illinois No. 24.

	Mine samples.		Car B sample.[a]	Steaming tests.[b]		
				335.	336.	337.
Laboratory No	2854	2855	2972			
Air-drying loss	10.10	9.60	7.40			
Proximate:						
Moisture	13.43	12.73	11.44	12.14	12.60	13.52
Volatile matter	33.02	33.35	33.93	33.71	34.40	32.84
Fixed carbon	44.37	44.32	43.92	42.48	43.13	43.17
Ash	9.18	9.60	10.71	11.67	9.87	10.47
Sulphur	3.35	3.60	4.94	4.53	3.83	3.97
Ultimate:						
Hydrogen			5.39	4.61	4.77	4.71
Carbon			60.06	67.18	69.47	68.61
Nitrogen			1.02	1.14	1.18	1.17
Oxygen			17.88	8.63	8.91	8.81
Ash				13.28	11.29	12.11
Sulphur				5.16	4.38	4.59
Calorific value (as received):						
Determined, calories	6,076		6,088			
Determined, B. t. u.	10,937		10,958			
Calculated from ultimate analysis, calories			6,049			
Calculated from ultimate analysis, B. t. u.			10,888			

[a] Sample from producer-gas test 103 treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of fuel figured from car sample.

STEAMING TESTS.

Illinois No. 24 B (lump).

	Test 335.	Test 336.	Test 337.
Size as used:			
Over 2 inches, per cent			92.0
Over 1 inch, do	49.7	22.1	
½ inch to 1 inch, do	19.9	25.2	3.2
¼ inch to ½ inch, do	12.4	19.6	1.6
Under ¼ inch, do	18.0	33.1	3.2
Duration of test, hours	9.62	6.05	[a] 3.88
Heating value of coal, B. t. u. per pound dry coal	12,245	12,623	12,474
Force of draft:			
Under stack damper, inch water	0.55	0.63	0.61
Above fire, do	.22	.26	.20
Furnace temperature, °F.	2,708		
Dry coal used per square foot of grate surface per hour, pounds	20.49	21.48	23.63
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.30	3.29	3.82
Percentage of rated horsepower of boiler developed	92.6	92.3	107.0
Water apparently evaporated per pound of coal as fired, pounds	5.90	5.59	5.84
Water evaporated from and at 212° F.:			
Per pound of coal as fired, do	7.09	6.71	7.00
Per pound of dry coal, do	8.07	7.67	8.10
Per pound of combustible, do	9.50	8.97	9.43
Efficiency of boiler, including grate, per cent	63.64	58.68	62.71
Coal as fired:			
Per indicated horsepower hour, pounds	3.99	4.21	4.04
Per electrical horsepower hour, do	4.93	5.20	4.99
Dry coal:			
Per indicated horsepower hour, do	3.50	3.69	3.49
Per electrical horsepower hour, do	4.33	4.55	4.31

[a] Too short for reliable results.

PRODUCER-GAS TEST.

Illinois No. 24 B (lump).

Test 103.—Size as used: Over 1 inch, 63 per cent; ½ inch to 1 inch, 16 per cent; ¼ inch to ½ inch, 10 per cent; under ¼ inch, 11 per cent. Duration of test, 50 hours; average electrical horsepower, 200.4; average B. t. u. per cubic foot of gas, 160.5; total coal fired, 14,650 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.54	1.36	1.19
Developed at switch board	1.46	1.29	1.14
Per brake horsepower:			
Commercially available	1.31	1.16	1.02
Developed at engine	1.24	1.10	0.97
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.63	1.45	1.27
Developed at switch board	1.55	1.38	1.21
Per brake horsepower:			
Commercially available	1.39	1.23	1.08
Developed at engine	1.32	1.17	1.03

Analysis of gas, by volume.[a]

Carbon dioxide (CO_2)	8.4	Nitrogen (N_2)	52.5
Carbon monoxide (CO)	22.6	Oxygen (O_2)	.1
Hydrogen (H_2)	13.8	Ethylene (C_2H_4)	.5
Methane (CH_4)	2.1		

WASHING AND COKING TESTS.

Illinois No. 24.

Washing tests.

	Test 169 (A).	Test. 166 (B).		Test. 169 (A).	Test 166 (B).
Size as shipped	sc.	l.	Raw coal, pounds	20,000	18,745
Size as used	sc.	cr. to 2".	Washed coal, do	15,000	16,660
Jig used	Stewart.	Stewart.	Refuse, do	5,000	2,085

Coking tests.

	A.		B.
	Test 119 (raw).	Test 155 (w.).	Test 145 (w.).
Size as shipped	sc.	sc.	l.
Size as used	sc.	f. c.	f. c.
Duration of test, hours	24	78	55
Coal charged, pounds	10,000	11,410	11,830
Coke produced, do	None.	None.	4,710
Coke produced, per cent			39.81
Breeze produced, pounds			1,350
Breeze produced, per cent			11.41
Total yield, do			51.22

Remarks.—Test 119: Ashed over whole oven about 4 inches down. Test 155: All volatile driven off. High heat of by-product ovens might coke. Test 145: Poor, soft, dense coke; sulphur high.

[a] For analysis of the fuel used see p. 98 (car sample 2972).

Analyses.

	Washing test 169 (A).		Washing test 166 (B, washed coal).	Coking test 119 (A coal).	Coking test 155 (A coal).	Coking test 145 (B).	
	Raw coal.[a]	washed coal.				Coal.	Coke.
Moisture	11.44	15.10	14.36	13.28	15.18	8.93	5.62
Volatile matter	33.93	.....	.....	29.93	32.13	35.22	1.64
Fixed carbon	43.92	.....	.....	39.03	43.46	46.29	79.01
Ash	10.71	9.75	8.38	17.76	9.23	9.56	13.73
Sulphur	4.94	3.18	3.31	4.05	3.07	3.41	2.97

[a] Sample from producer-gas test 103 (on B coal).

ILLINOIS NO. 25.

Bituminous coal from a mine located one-half mile east of Germantown, Clinton County, on the Southern Railway, was designated Illinois No. 25. The coal, as worked at a depth of 345 feet at this place, averages 4 feet 8 inches in thickness.

This sample was shipped under the supervision of John W. Groves. Two lots of coal, consisting of run of mine (designated A) and lump (designated B), the latter over a $1\frac{3}{4}$-inch screen, were shipped in the same car, and separated from each other by a partition. The following tests were made: On A and B mixed, steaming tests 338 and 339; on A, washing test 162 and coking tests 120 (raw) and 140 (washed), and on B, producer-gas test 104.

Two mine samples were taken for chemical analysis. Sample 2856 was cut 2,100 feet north of the shaft, where the coal measured 4 feet 10 inches in thickness. Sample 2857 was taken 2,200 feet northwest of the shaft, where the coal measured 4 feet 6 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 25.

	Mine samples.		Car sample (B).[a]	Steaming tests.[b]	
				338.	339.
Laboratory No	2856	2857	2991	.....	.....
Air-drying loss	6.70	7.60	5.90	.....	.....
Proximate:					
Moisture	11.64	12.15	11.35	12.28	11.53
Volatile matter	35.41	35.60	34.62	35.52	34.93
Fixed carbon	44.29	42.97	40.63	40.53	39.75
Ash	8.66	9.28	13.40	11.67	13.79
Sulphur	3.41	4.01	4.76	3.57	4.89
Ultimate:					
Hydrogen	.....	.....	5.41	4.87	4.65
Carbon	.....	.....	57.36	67.23	64.20
Nitrogen	.....	.....	1.05	1.23	1.18
Oxygen	.....	.....	18.02	9.30	8.85
Ash	.....	.....	.....	13.30	15.59
Sulphur	.....	.....	.....	4.07	5.53
Calorific value (as received):					
Determined (calories)	6,272	.....	5,963	.....	.....
Determined (B. t. u.)	11,290	.....	10,733	.....	.....
Calculated from ultimate analysis (calories)	.....	.....	5,831	.....	.....
Calculated from ultimate analysis (B. t. u.)	.....	.....	10,496	.....	.....

[a] Sample from producer-gas test 104 treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Illinois No. 25 (run of mine and lump mixed).

	Test 338.	Test 339.
Size as used:		
Over 3½ inches.....per cent..	3.33	.....
3½ inches to 2½ inches.....do....	28.1	.....
3 inches.....do....	.....	56.0
1½ inches to 1 inch.....do....	.....	26.4
½ inch to 1 inch.....do....	14.3	7.2
¼ inch to ½ inch.....do....	9.1	4.0
Under ¼ inch.....do....	15.2	6.4
Duration of test.....hours..	9.67	10.0
Heating value of coal.....B. t. u. per pound dry coal..	12,519	12,022
Force of draft:		
Under stack damper.....inch water..	0.75	0.74
Above fire.....do....	.21	.21
Dry coal used per square foot of grate surface per hour.....pounds..	21.36	23.63
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.10	3.54
Percentage of rated horsepower of boiler developed.....	87.0	99.1
Water apparently evaporated per pound of coal as fired.....pounds..	5.35	5.55
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	6.38	6.63
Per pound of dry coal.....do....	7.28	7.50
Per pound of combustible.....do....	8.68	9.19
Efficiency of boiler, including grate.....per cent..	56.16	60.25
Coal as fired:		
Per indicated horsepower hour.....pounds..	4.43	4.26
Per electrical horsepower hour.....do....	5.47	5.27
Dry coal:		
Per indicated horsepower hour.....do....	3.88	3.77
Per electrical horsepower hour.....do....	4.80	4.66

PRODUCER-GAS TEST.

Illinois No. 25 B (lump).

Test 104.—Duration of test, 50 hours; average electrical horsepower, 200.6; average B. t. u. per cubic foot of gas, 168.0; total coal fired, 16,000 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.68	1.49	1.27
Developed at switch board	1.60	1.41	1.20
Per brake horsepower:			
Commercially available	1.43	1.27	1.08
Developed at engine	1.36	1.20	1.02
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.78	1.58	1.34
Developed at switch board	1.68	1.49	1.27
Per brake horsepower:			
Commercially available	1.51	1.34	1.14
Developed at engine	1.43	1.27	1.08

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	8.3
Carbon monoxide (CO)	22.5
Hydrogen (H_2)	13.6
Methane (CH_4)	2.2
Nitrogen (N_2)	52.9
Ethylene (C_2H_4)	.5

[a] For analysis of the fuel used, see p. 100 (car sample 2991).

WASHING AND COKING TESTS.

Illinois No. 25 A (run of mine).

Washing test 162.—Size as used, crushed to 2 inches. Jig used, Stewart. Raw coal, 14,550 pounds; washed, 12,000 pounds; refuse, 2,550 pounds.

Coking tests.

		Test 120 (raw).	Test 140 (w.).
Size as used		r. o. m.	f. c.
Duration of test	hours	79	62
Coal charged	pounds	10,000	11,830
Coke produced	do	None.	5,355
	per cent		45.27
Breeze produced	pounds		710
	per cent		6.00
Total yield	do		51.27

Remarks.—Test 140: Dull-gray color, cell structure close; soft, dense coke; breakage poor. Coked in two distinct layers of 16 inches and 8 inches, the lower coming out in chunks.

Analyses.

	Washing test 162 (washed coal).[a]	Coking test 120 (coal).	Coking test 140.	
			Coal.	Coke.
Moisture	14.14	12.96	13.40	2.71
Volatile matter		33.01	33.83	4.67
Fixed carbon		39.60	43.66	77.69
Ash	8.98	14.43	9.11	14.93
Sulphur	3.05	4.09	2.99	2.32

[a] For analysis of raw coal from this mine, see p. 100 (analysis 2991, of B (lump) coal).

ILLINOIS NO. 26.

Bituminous coal from Lincoln, Logan County, on the Chicago and Alton Railroad, was designated Illinois No. 26. The coal, as worked at a depth of 276 feet at this place, averages 4 feet 11 inches in thickness.

This sample was shipped under the supervision of John W. Groves. It consisted of run-of-mine coal and was used in making steaming tests 341 and 342, producer-gas test 126, washing test 164, and coking test 143 (on washed coal).

Two mine samples were taken for chemical analysis. Sample 2881 was taken 1,500 feet southeast of the shaft, where the coal measured 4 feet 11 inches in thickness. Sample 2882 was taken 1,600 feet northeast of the shaft, where the coal measured 4 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 26.

	Mine sample.		Car sample.	Steaming tests.[a]	
				341.	342.
Laboratory No.	2881	2882	[b] 3003	.....	.....
Air-drying loss	11.30	12.10	12.70	.....	.....
Proximate:					
Moisture	14.77	15.52	15.68	13.55	15.68
Volatile matter	32.90	32.27	32.41	33.11	32.41
Fixed carbon	39.75	39.86	39.82	40.24	39.82
Ash	12.58	12.35	12.09	13.10	12.09
Sulphur	3.95	3.65	3.51	4.45	3.51
Ultimate:					
Hydrogen	.....	.....	5.56	4.43	4.53
Carbon	.....	.....	56.76	65.81	67.31
Nitrogen	.....	.....	1.06	1.23	1.26
Oxygen	.....	.....	21.02	8.23	8.40
Ash	.....	.....	.....	15.15	14.34
Sulphur	.....	.....	.....	5.15	4.16
Calorific value (as received):					
Determined (calories)	.....	.....	5,675	.....	.....
Determined (B. t. u.)	.....	.....	10,215	.....	.....
Calculated from ultimate analysis (calories)	5,781	.....	5,743	.....	.....
Calculated from ultimate analysis (B. t. u.)	10,406	.....	10,337	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Results figured from sample from steaming test 342.

STEAMING TESTS.

Illinois No. 26 (run of mine).

	Test 341.	Test 342.
Size as used:		
3½ inches.....per cent	.....	61.0
3 inches.....do	58.6	.....
2½ inches to 1 inch.....do	.....	17.1
1½ inches to 1 inch.....do	19.9	.....
½ inch to 1 inch.....do	8.9	9.2
¼ inch to ½ inch.....do	4.4	5.8
Under ¼ inch.....do	8.2	6.9
Duration of test.....hours	10.0	8.87
Kind of grate	Rocking.	Rocking.
Heating value of coal.....B. t. u. per pound dry coal	12,029	12,260
Force of draft:		
Under stack damper.....inch water	0.65	0.64
Above fire.....do	.34	.30
Furnace temperature.....°F	.....	2,264
Dry coal used per square foot of grate surface per hour.....pounds	20.91	23.02
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds	2.84	3.16
Percentage of rated horsepower of boiler developed	79.7	88.6
Water apparently evaporated per pound of coal as fired.....pounds	5.52	5.40
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do	6.56	6.47
Per pound of dry coal.....do	7.58	7.67
Per pound of combustible.....do	9.29	9.29
Efficiency of boiler, including grate.....per cent	60.85	60.42
Coal as fired:		
Per indicated horsepower hour.....pounds	4.31	4.37
Per electrical horsepower hour.....do	5.32	5.40
Dry coal:		
Per indicated horsepower hour.....do	3.73	3.69
Per electrical horsepower hour.....do	4.61	4.55

PRODUCER-GAS TEST.

Illinois No. 26 (run of mine).

Test 126.—Duration of test, 50 hours; average electrical horsepower, 174.5; average B. t. u. per cubic foot of gas, 147.2; total coal fired, 16,050 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.96	1.70	1.39
Developed at switchboard	1.84	1.59	1.30
Per brake horsepower:			
Commercially available	1.67	1.45	1.18
Developed at engine	1.56	1.36	1.11
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.13	1.85	1.51
Developed at switchboard	2.00	1.73	1.41
Per brake horsepower:			
Commercially available	1.81	1.57	1.28
Developed at engine	1.70	1.47	1.20

Analyses.

Coal.		*Gas by volume.*	
Moisture	13.29	Carbon dioxide (CO_2)	10.5
Volatile matter	32.02	Carbon monoxide (CO)	19.4
Fixed carbon	38.81	Hydrogen (H_2)	15.5
Ash	15.88	Methane (CH_4)	1.7
Sulphur	3.52	Nitrogen (N_2)	52.5
		Ethylene (C_2H_4)	.4

WASHING AND COKING TESTS.

Illinois No. 26 (run of mine).

Washing test 164.—Size as used, crushed to 2 inches. Jig used, Stewart. Raw coal 18,000 pounds; washed coal, 16,000 pounds; refuse, 2,000 pounds.

Coking test 143.—Size as used, washed, finely crushed. Duration of test, 59 hours. Coal charged, 11,750 pounds; coke produced, 5,850 pounds; 49.79 per cent. Breeze produced, 1,250 pounds; 10.64 per cent. Total yield, 60.43 per cent. Soft dense coke. Coal particles stuck together after volatile expelled.

Analyses.

	Washing test 164.		Coking test 143.	
	Raw coal.[a]	Washed coal.	Coal.	Coke.
Moisture	15.68	15.96	15.18	5.27
Volatile matter	32.41	.....	33.46	3.35
Fixed carbon	39.82	.....	41.53	75.98
Ash	12.09	9.40	9.83	15.40
Sulphur	3.51	2.76	2.73	2.80

[a] Sample taken from steaming test 342.

ILLINOIS NO. 27.

Bituminous coal from Auburn, Sangamon County, on the Chicago and Alton Railroad, was designated Illinois No. 27. The coal is reached by shaft at this place, and averages 6 feet 6 inches in thickness.

This sample consisted of run-of-mine coal and was shipped under the supervision of John W. Groves. It was used in making steaming tests 353 and 354; producer-gas test 127; washing test 165; and coking test 144 (washed coal).

Two mine samples were taken for chemical analysis. Sample 2897 was taken 2,000 feet southeast of the shaft, where the coal measured 6 feet 10 inches in thickness. Sample 2898 was taken 1,400 feet south of the shaft, where the coal measured 6 feet 10 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 27.

	Mine sample.		Car sample.[a]	Steaming test.[b]	
				353.	354.
Laboratory No	2897	2898	3052		
Air-drying loss	10.20	10.50	10.00		
Proximate:					
Moisture	14.29	14.18	16.00	16.00	15.82
Volatile matter	37.17	34.85	32.41	32.41	32.50
Fixed carbon	40.36	41.11	37.82	37.82	37.73
Ash	8.18	9.86	13.77	13.77	13.95
Sulphur	4.41	4.36	4.05	4.05	4.80
Ultimate:					
Hydrogen			5.55	4.49	4.43
Carbon			53.89	64.15	63.29
Nitrogen			.91	1.08	1.07
Oxygen			21.83	9.07	8.94
Ash				16.39	16.57
Sulphur				4.82	5.70
Calorific value:					
Determined, calories	6,115		5,522		
Determined, B. t. u.	11,007		9,940		
Calculated from ultimate analysis, calories			5,417		
Calculated from ultimate analysis, B. t. u.			9,751		

[a] Sample taken from steaming test 353.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Illinois No. 27.

	Test 353.	Test 354.
Size as used:		
Over 1 inch, per cent	72.4	34.6
½ inch to 1 inch, do	11.1	25.7
¼ inch to ½ inch, do	6.8	17.6
Under ¼ inch, do	9.7	22.1
Average diameter, inches	2.29	.93
Duration of test, hours	10.00	10.02
Heating value of coal, B. t. u. per pound dry coal	11,831	11,713
Force of draft:		
Under stack damper, inch water	0.60	0.72
Above fire, do	.18	.17
Furnace temperature, °F	2,360	2,162
Dry coal used per square foot of grate surface per hour, pounds	19.83	19.26
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.14	3.08
Percentage of rated horsepower of boiler developed	88.0	86.4
Water apparently evaporated per pound of coal as fired, pounds	5.57	5.60
Water evaporated from and at 212° F.:		
Per pound of coal as fired, do	6.66	6.75
Per pound of dry coal, do	7.93	8.02
Per pound of combustible, do	9.65	9.85
Efficiency of boiler, including grate, per cent	64.73	66.12
Coal as fired:		
Per indicated-horsepower hour, pounds	4.24	4.19
Per electrical-horsepower hour, do	5.24	5.17
Dry coal:		
Per indicated-horsepower hour, do	3.56	3.53
Per electrical-horsepower hour, do	4.40	4.36

PRODUCER-GAS TEST.

Illinois No. 27 (run of mine).

Test 127.—Average electrical horsepower, 124.8; average B. t. u. per cubic foot of gas, 122.5; total coal fired, 16,050 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.83	2.51	2.12
Developed at switch board	2.57	2.28	1.92
Per brake horsepower:			
Commercially available	2.40	2.13	1.80
Developed at engine	2.19	1.94	1.63
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	3.06	2.72	2.29
Developed at switch board	2.78	2.47	2.08
Per brake horsepower:			
Commercially available	2.60	2.31	1.95
Developed at engine	2.36	2.10	1.77

Analyses.

Coal.		*Gas by volume.*	
Moisture	11.35	Carbon dioxide (CO_2)	12.4
Volatile matter	33.59	Carbon monoxide (CO)	15.0
Fixed carbon	41.20	Hydrogen (H_2)	12.9
Ash	13.86	Methane (CH_4)	1.6
Sulphur	4.54	Nitrogen (H_2)	57.7
		Ethylene (C_2H_4)	.4

WASHING AND COKING TESTS.

Illinois No. 27 (run of mine).

Washing test 165.—Size as used, crushed to 2 inches. Jig used, Stewart. Raw coal, 18,000 pounds; washed, 15,545 pounds; refuse, 2,455 pounds.

Coking test 144.—Size as used, washed, finely crushed. Duration of test, 53 hours; coal charged, 11,550 pounds; coke produced, 5,067 pounds; 43.87 per cent; breeze produced, 405 pounds; 3.51 per cent. Total yield, 47.38 per cent. Soft, dense coke; very little cell structure; high sulphur.

Analyses.

	Washing test 165.		Coking test 144.	
	Raw coal.[a]	Washed coal.	Coal.	Coke.
Moisture	16.00	16.11	16.39	3.51
Volatile matter	32.41	.....	34.26	1.55
Fixed carbon	37.82	.....	41.57	81.14
Ash	13.77	7.76	7.78	13.80
Sulphur	4.05	3.26	3.22	3.40

[a] Sample taken from steaming test 353.

ILLINOIS NO. 28.

Bituminous coal from bed No. 7 at Herrin, Williamson County, was designated Illinois No. 28. This coal, as worked at a depth of 167 feet at this place, averages 6 feet 11 inches in thickness.

Three shipments of coal for testing purposes were made from this mine. Illinois No. 28 A consisted of No. 5 washed coal, was shipped uninspected, and was used in steaming test 459 (on briquets) and in briquetting tests 140*, 141*, 142*, 143*, 162, and 163. Illinois No. 28 B consisted of unwashed screenings shipped uninspected, and was used in steaming test 457 (on briquets) and briquetting tests 144*, 158*, 159, 160*, and 161. Illinois No. 28 C consisted of lump coal which passed over a 3-inch round shaking screen, was shipped under the supervision of K. M. Way, and was used in steaming tests 448 and 452, washing test 181, and coking test 166.

Two mine samples were taken for chemical analysis. Sample 3629 was taken 2,400 feet west of the shaft, where the coal measured 7 feet in thickness. Sample 3632 was taken 2,250 feet northwest of the shaft, where the coal measured 6 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 28.

	Mine sample.		Car sample (C).	Steaming tests.[a]				Briquetting tests.[b]				
				A.	B.	C.		A.			B.	
				459.	457.	448.	452.	140*.	142*.	143*.	144*.	158*, 159, and 160*.
Laboratory No.	3629	3632	3789	.....	4121	.....	.....	.....	.....	4066	4144	4150
Air-drying loss	.....	.....	3.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
Proximate:												
Moisture	8.72	8.88	7.78	7.32	5.81	4.82	7.02	5.81	5.75	5.78	6.38	5.45
Volatile matter	30.38	29.49	29.85	30.72	30.86	30.81	29.93	30.31	31.06	30.58	31.07	31.65
Fixed carbon	53.28	53.60	52.39	49.84	52.41	53.82	53.51	49.58	51.50	51.02	51.19	51.74
Ash	7.62	8.03	9.98	12.12	10.92	10.55	9.54	14.30	12.61	12.62	11.36	11.16
Sulphur	1.00	.99	1.32	1.29	2.03	1.47	1.18	1.25	1.21	.95	1.55	2.04
Ultimate:												
Hydrogen	.....	.....	5.06	4.21	4.60	4.54	4.59	4.21	4.16	4.35	4.22	4.19
Carbon	.....	.....	67.45	71.88	71.92	72.85	73.75	69.69	71.92	71.89	71.82	71.62
Nitrogen	.....	.....	1.21	1.59	1.37	1.30	1.32	1.36	1.35	1.36	1.39	1.43
Oxygen	.....	.....	14.98	7.85	8.36	8.68	8.81	8.23	7.95	8.00	8.78	8.80
Ash	.....	.....	.....	13.08	11.59	11.09	10.26	15.18	13.34	13.39	12.13	11.80
Sulphur	.....	.....	.....	1.39	2.10	1.54	1.27	1.33	1.28	1.01	1.66	2.16
Calorific value determined (as received) calories	6,77	.....	6,644	.....	.....	.....	.....	.....	.....	.....	.....	.....
Calorific value determined (as received) B. t. u.	12,200	.....	11,959	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Illinois No. 28.

	A.	B.	C.	
	Test 459 (w.).	Test 457.	Test 448.	Test 452.
Size as used:				
Over 1 inch....per cent..			32.3	58.4
½ inch to 1 inch....do....			22.1	21.3
¼ inch to ½ inch....do....	(a)	(a)	13.7	9.0
Under ¼ inch....do....			31.9	11.13
Average diameter....inches..			.79	1.12
Duration of test....hours..	9.95	9.13	10.03	10.00
Heating value of fuel....B. t. u. per pound dry fuel..	12,557	12,859	12,920	13,070
Force of draft:				
Under stack damper....inch water..	0.80	0.81	0.76	0.74
Above fire....do....	.15	.16	.17	.14
Furnace temperature....°F..	2,601	2,606	2,862	2,833
Dry fuel used per square foot of grate surface per hour, pounds....	18.72	19.85	22.52	21.97
Equivalent water evaporated per square foot of water-heating surface per hour....pounds..	3.13	3.42	3.88	3.94
Percentage of rated horsepower of boiler developed....	87.7	95.9	108.8	110.5
Water apparently evaporated per pound of fuel as fired, pounds....	6.43	6.78	7.01	6.97
Water evaporated from and at 212° F.:				
Per pound of fuel as fired....do....	7.75	8.13	8.21	8.35
Per pound of dry fuel....do....	8.36	8.64	8.63	8.98
Per pound of combustible....do....	9.79	10.11	9.99	10.36
Efficiency of boiler, including grate....per cent..	64.29	64.99	64.50	66.35
Fuel as fired:				
Per indicated horsepower hour....pounds..	3.65	3.48	3.44	3.39
Per electrical horsepower hour....do....	4.50	4.29	4.25	4.18
Dry fuel:				
Per indicated horsepower hour....do....	3.38	3.27	3.28	3.15
Per electrical horsepower hour....do....	4.18	4.04	4.05	3.89

a See p. 109.

Remarks.—Test 459 on briquets from tests 162 and 163 (equal weights) and English briquets; fired whole; no smoke from either kind. Test 457 on briquets from tests 159 and 161 (equal weights); made 4 per cent black smoke.

WASHING AND COKING TEST.

Illinois No. 28 C (lump).

Washing test 181.—Size as used, 2-inch; jig used, Stewart; raw coal, 24,000 pounds; washed coal, 19,925 pounds, 74 per cent; refuse, 4,075 pounds, 26 per cent.

Coking test 166.—Size as used, washed, finely crushed. Duration of test, 60 hours. Coal charged, 12,600 pounds; coke produced, 6,350 pounds, 50.40 per cent; breeze produced, 661 pounds, 5.25 per cent. Total yield, 55.65 per cent; dark-gray color; poor, dense coke.

Analysis.

	Washing test 181.		Coking test 166.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	7.78	9.75	9.37	2.82
Volatile matter	29.85	.....	30.38	.60
Fixed carbon	52.39	.....	53.36	86.12
Ash	9.98	7.12	6.89	10.46
Sulphur	1.32	1.05	1.09	.98
Phosphorus	.....	.....	.....	.0075

BRIQUETTING TESTS.

Illinois No. 28.

Tests 140, 141*, 142*, 143*, 162, 163 (coal A, washed screenings.)*—Size as used: $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 3.0 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 13.0 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 20.2 per cent; through $\frac{1}{40}$ inch, 63.8 per cent. There was no appreciable difference in briquets with 6, 7, and 8 per cent binder made on English machine and 8 per cent on Renfrow machine. Renfrow briquets made with less than 8 per cent binder were not satisfactory. The satisfactory briquets had hard, smooth outer surfaces, broke with clean rough fracture without crumbling, and edges were hard and sharp. Renfrow briquets could be handled warm and piled without crushing.

For analyses of briquets from tests 162 and 163 see page 108 (steaming test 459).

	Test 140*.	Test 141*.	Test 142*.	Test 143*.	Test 162.	Test 163.
Details of manufacture:						
Machine used	Eng.	Eng.	Eng.	Renf.	Renf.	Eng.
Temperature of briquets °F.	185	185	185	131	131	185
Binder—						
Kind	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	3410	3410	3410	3410	3885	3885
Amount per cent.	6	7	8	8	8	7
Weight of—						
Fuel briquetted pounds.	16,000	16,000	16,000	134,000	40,000	8,000
Briquets, average do.	3.44	3.54	3.45	.502	.463	3.62
Heat value per pound—						
Fuel as received B. t. u.	10,611	10,611	10,611	10,611	10,611	10,611
Fuel as fired do.	.....	11,567	11,927	12,026	11,637	11,637
Binder do.	16,478	16,478	16,478	16,478	16,870	16,870
Drop test (1-inch screen):						
Held per cent.	.....	.....	.....	.....	61.5	.....
Passed do.	.....	.....	.....	.....	38.5	.....
Tumbler test (1-inch screen):						
Held do.	.....	.....	.....	.....	73.5	.....
Passed (fines) do.	.....	.....	.....	.....	26.5	.....
Fines through 10-mesh sieve do.	.....	.....	.....	.....	94.5	.....
Weathering test:						
Time exposed days.	182	182	182	173	127	173
Condition	A.	B.	A.	B.	B.	B.
Water absorption:						
In 19 days per cent.	.....	.....	.....	.....	13.6	.....
Average for first 5 days do.	.....	.....	.....	.....	1.84	.....
Specific gravity (apparent)	.....	.....	.....	.....	1.041	.....

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 143*.
Laboratory No	3410	3409	4066
Air-drying loss per cent.	.....	9.30	.....
Extracted by CS_2:			
Air dried do.	.....	.23	.....
As received do.	79.98	.21	9.15
Pitch in briquets, as received do.	.....	.....	11.21

Tests 144, 158*, 159, 160*, 161 (coal B, raw screenings).*—Size as used: Over $\frac{1}{4}$ inch, 0.4 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 3.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 13.4 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 24.8 per cent; through $\frac{1}{40}$ inch, 57.6 per cent. These briquets showed the same characteristics as those made from Illinois No. 28 A, except that when cold their surfaces were tougher and less liable to break down from abrasion than those of the briquets from the washed fuel. For analyses of briquets from test 161 see page 108 (steaming test 457).

	Test 144*.	Test 158*.	Test 159.	Test 160*.	Test 161.
Details of manufacture:					
Machine used	Renf.	Eng.	Eng.	Eng.	Renf.
Temperature of briquets °F.	131	185	185	185	131
Binder—					
Kind	w. g. p.	c. t. p.	c. t. p.	c. t. p.	w. g. p.
Laboratory No. (see p. 40)	3486 and 3624	3692	3692	3692	3692 and 3885
Amount per cent.	8	6	7	8	8
Weight of—					
Fuel briquetted pounds.	123,000	20,000	28,000	20,000	30,000
Briquets, average do.	0 524	3. 50	3. 51	3. 63	0. 481
Heat value per pound—					
Fuel as received B. t. u.	11,329	11,329	11,329	11,329	11,329
Fuel as fired do.	12,094	12,161	12,161	12,161	12,092
Binder do.	a 16,300	16,103	16,103	16,103	16,870
Drop test (1-inch screen):					
Held do.	49. 0	77. 9	72. 3	80. 6	41. 0
Passed do.	51. 0	22. 1	27. 7	19. 4	59. 0
Tumbler test (1-inch screen):					
Held do.	79. 0	77. 8	72. 1	66. 4	59. 5
Passed (fines) do.	21. 0	22. 2	27. 9	33. 6	40. 5
Fines through 10-mesh sieve do.	85. 0	80. 0	87. 7	78. 3	89. 5
Weathering test:					
Time exposed days.	141	143	137	137	112
Condition	C.	B.	B.	B.	C.
Water absorption:					
In 19 days per cent.	15. 5	14. 3	12. 6	13. 9	16. 0
Average for first 5 days do.	1. 98	1. 40	1. 30	1. 40	2. 14
Specific gravity (apparent)	1. 075	1. 092	1. 112	1. 075	1. 038

a Equal weights of two binders were used and the calorific value determined from the separate calorific values of the binders.

Extraction analyses.

	Pitches.				Fuel.	Briquets.		
						Test 144*.	Tests 158*, 159, 160*.	Test 161.
Laboratory No.	3486	3624	3692	3885	3423	4144	4150	4121
Air-drying loss per cent.					6. 20			2. 90
Extracted by CS_2:								
Air dried do.					. 25			5. 96
As received do.	85. 57	99. 60	69. 71	95. 20	. 23	7. 54	5. 12	5. 79
Pitch in briquets, as received do.						8. 57	7. 02	6. 77

ILLINOIS NO. 29.

Bituminous coal from bed No. 5 at Livingston, Madison County, was designated Illinois No. 29. This coal. as worked at a depth of 286 feet at this place, averages 6 feet 10 inches in thickness.

Two samples were shipped under the supervision of K. M. Way, as follows: Illinois No. 29 A consisted of screenings through a 2-inch shaking screen and was used in steaming test 465 (on briquets); washing tests 183 and 184; coking tests 169 and 170; cupola tests 150, 157, and 164; and briquetting tests 170 and 171†. Illinois No. 29 B consisted of run-of-mine coal and was used in steaming tests 460, 461, and 466 (on briquets); producer-gas test 139, and briquetting test 175†.

Two mine samples were taken for chemical analysis. Sample 3911 was taken 1,600 feet south of the shaft, where the coal measured 7 feet 1½ inches in thickness. Sample 3913 was taken 1,200 feet

northwest of the shaft, where the coal measured 6 feet 6¾ inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 29.

	Mine samples.		Car samples.			Steaming tests.[a]				Briquetting test 171† (A).[b]
						A.	B.			
			B.	A.	B.	465.	460.	461.	466.	
Laboratory No.	3911	3913	3958	3963	3980	4233	.....	.....	4245	.....
Air-drying loss	.....	.....	7.30	8.60	5.50	.....	.....	.....	.....	.....
Proximate:										
Moisture	14.25	12.69	12.47	13.10	12.25	14.23	11.09	12.41	10.00	12.29
Volatile matter	35.52	37.40	33.12	30.73	33.76	34.63	33.68	35.42	36.33	37.16
Fixed carbon	40.79	41.15	41.85	40.12	41.66	43.96	41.17	42.15	43.01	43.99
Ash	9.44	8.76	12.56	16.00	12.33	7.18	14.06	10.02	10.66	6.56
Sulphur	3.72	3.62	4.37	4.17	4.42	2.84	4.63	3.51	3.24	3.56
Ultimate:										
Hydrogen	.....	.....	5.37	5.26	5.44	4.78	4.45	4.77	4.82	4.91
Carbon	.....	.....	57.17	54.26	58.30	72.39	63.96	68.47	69.45	72.23
Nitrogen	.....	.....	1.00	.89	.80	1.08	1.11	1.20	1.26	1.07
Oxygen	.....	.....	19.53	19.42	18.71	10.07	9.46	10.11	9.03	10.26
Ash	.....	.....	.....	.....	.....	8.37	15.81	11.44	11.84	7.47
Sulphur	.....	.....	.....	.....	.....	3.31	5.21	4.01	3.60	4.06
Calorific value determined (as received) calories	6,051	6,242	5,926	5,546	5,955	.....	.....	.....	.....	.....
Calorific value determined (as received) B. t. u.	10,892	11,236	10,667	9,983	10,719	.....	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Illinois No. 29.

	A.	B.		
	Test 465.	Test 460.	Test 461.	Test 466.
Size as used:				
Over 1 inch, per cent	See p. 114.	34.1	51.4	See p. 114.
½ inch to 1 inch, do		21.5	22.4	
¼ inch to ½ inch, do		13.2	10.7	
Under ¼ inch, do		31.2	15.5	
Average diameter, inches		0.81	1.04	
Duration of test, hours	9.98	10.05	5.42	10.07
Heating value of fuel, B. t. u. per pound dry fuel	13,120	11,945	12,728	12,762
Force of draft:				
Under stack damper, inch water	0.81	0.80	0.84	0.82
Above fire, do	.15	.18	.18	.16
In ash pit, do	.....	.....	.....	.....
Furnace temperature, °F.	2,665	2,759	2,816	2,784
Dry fuel used per square foot of grate surface per hour, pounds	20.35	21.38	22.32	22.32
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.62	3.44	3.72	3.90
Percentage of rated horsepower of boiler developed	101.5	96.3	104.2	109.2
Water apparently evaporated per pound of fuel as fired, pounds	6.34	5.93	6.05	6.52
Water evaporated from and at 212° F.:				
Per pound of fuel as fired, pounds	7.65	7.16	7.31	7.87
Per pound of dry fuel, do	8.91	8.05	8.34	8.74
Per pound of combustible, do	9.89	9.88	9.58	10.03
Efficiency of boiler, including grate, per cent	65.58	65.08	63.28	66.14
Fuel as fired:				
Per indicated horsepower hour, pounds	3.70	3.95	3.87	3.59
Per electrical horsepower hour, do	4.56	4.88	4.78	4.44
Dry fuel:				
Per indicated horsepower hour, do	3.17	3.51	3.39	3.24
Per electrical horsepower hour, do	3.92	4.34	4.19	3.99

Remarks.—Test 465 on English and Renfrow briquets from tests 170 and 171† (equal weights) burned with medium-length flame, making 6 per cent black smoke; 42 per cent clinker, very hard, brittle, and of a dark-gray color and glassy fracture. Test 466 on briquets from test 175† burned with a hot fire, medium flame, making 13 per cent black smoke; 38 per cent clinker, gray, hard, porous; steam jet used to keep from sticking to grates; ash gray in color, gritty.

PRODUCER-GAS TEST.

Illinois No. 29 B (run of mine).

Test 139.—Size as used: Over 1 inch, 66 per cent; ½ inch to 1 inch, 17 per cent; ¼ inch to ½ inch, 7 per cent; under ¼ inch, 10 per cent. Duration of test, 50 hours. Average electrical horsepower, 194.3; average B. t. u. per cubic foot of gas, 141.2; total coal fired, 17,250 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.86	1.63	1.40
Developed at switchboard	1.70	1.56	1.34
Per brake horsepower:			
Commercially available	1.58	1.39	1.19
Developed at engine	1.51	1.33	1.14
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.00	1.75	1.51
Developed at switchboard	1.91	1.67	1.44
Per brake horsepower:			
Commercially available	1.70	1.49	1.28
Developed at engine	1.62	1.42	1.22

Analyses.

Coal.		*Gas by volume.*	
Moisture	12.25	Carbon dioxide (CO_2)	11.4
Volatile matter	33.76	Carbon monoxide (CO)	17.3
Fixed carbon	41.66	Hydrogen (H_2)	14.0
Ash	12.33	Methane (CH_4)	2.0
Sulphur	4.42	Nitrogen (N_2)	54.8
		Ethylene (C_2H_4)	.5

WASHING AND COKING TESTS.

Illinois No. 29 A (screenings).

Washing tests.

		Test 183.	Test 184.
Jig used		Stewart.	Stewart.
Raw coal	pounds.	18,000	59,500
Washed coal	do.	13,750	41,500
	per cent.	76	70
Refuse	pounds.	4,250	18,000
	per cent.	24	30

Coking tests (on washed coal).

		Test 169.	Test 170.
Size as used		f. c.	f. c.
Duration of test	hours.	74	54
Coal charged	pounds.	12,010	11,680
Coke produced	do.	4,950	4,950
	per cent.	41.22	42.38
Breeze produced	pounds.	684	338
	per cent.	5.70	2.89
Total yield	do.	46.92	45.27

Remarks.—Test 169: Poor, dense coke; high sulphur. Test 170: Better than test 169, but poor coke with high sulphur content.

Analyses.

	Washing test 183.		Washing test 184 (washed coal).	Coking test 169.		Coking test 170.	
	Raw coal.	Washed coal.		Coal.	Coke.	Coal.	Coke.
Moisture	13.10	15.86	15.86	15.63	0.72	18.39	2.78
Volatile matter	30.73	.....	.....	33.88	.90	32.87	.74
Fixed carbon	40.12	.....	.....	42.81	84.62	41.53	83.35
Ash	16.00	7.70	7.70	7.68	13.76	7.21	13.13
Sulphur	4.17	3.06	3.06	3.13	2.57	3.06	2.49

Cupola tests of coke made from Illinois No. 29 A coal (washed).

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
150	170	1.83	7	94.44	Coke	190	60	60	60	60	430
					Pig iron	760	560	560	560	560	3,000
157	170	1.83	6	97.22	Coke	190	78	78	77	77	500
					Pig iron	760	560	560	560	560	3,000
164	170	1.83	8	94.44	Coke	200	44	44	44	43	375
					Pig iron	800	550	550	550	550	3,000

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio, iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
150	10.59 a. m.	7	12	2,095	329	2,424	34	4,278	6.12	5.53	410	34
157	3.15 p. m.	7	10	2,195	466	2,661	31	5,150	6.02	5.37	178	58
164	11.10 a. m.	7	9	1,331	295	1,626	30	3,252	4.85	6.77	1,171	40

SILICON, MANGANESE, ETC.

Cupola test No.	Materials.	Amount used (lbs.).	Silicon. Per cent.	Silicon. Pounds.	Manganese. Per cent.	Manganese. Pounds.	Sulphur. Per cent.	Sulphur. Pounds.	Content of coke combined with iron melted (per cent).
150	Pig iron	.....	2.12	51.39	0.178	4.315	0.059	1.4302	
	Melted iron:								
	Amount	.....	1.91	46.30	.155	3.757	.086	2.0846	6.59
	Gain or loss	.....	− 9.90	− 5.09	−12.93	− .558	+ .027	+ .0544	
	Coke	399	.....	.....	.....	.....	2.49	9.9351	
157	Pig iron	.....	2.12	56.41	.178	4.737	.059	1.5700	
	Melted iron:								
	Amount	.....	1.84	48.96	.133	3.539	.108	2.8739	11.69
	Gain or loss	.....	−13.21	− 7.45	−25.29	−1.198	+ .049	+1.3039	
	Coke	448	.....	.....	.....	.....	2.49	11.1552	
164	Pig iron	.....	2.10	34.15	.163	2.650	.098	1.5935	
	Melted iron:								
	Amount	.....	1.68	27.32	.111	1.805	.133	2.1626	6.74
	Gain or loss	.....	−20.00	− 6.83	−31.90	− .845	+ .035	+ .5691	
	Coke	339	.....	.....	.....	.....	2.49	8.4411	

Cupola tests of coke made from Illinois No. 29 A coal (washed)—Continued.

LADLE RECORD.

Ladle No.	Test 150.[a]		Test 157.[a]		Test 164.[b]		Ladle No.	Test 150.[a]		Test 157.[a]		Test 164.[b]	
	Lbs.	Time (a.m.).	Lbs.	Time (p.m.).	Lbs.	Time (a.m.).		Lbs.	Time (a.m.).	Lbs.	Time (p.m.).	Lbs.	Time (a. m.)
1	55	11.14	19	3.28	86	11.25	13	66	11.30	88	3.44	84	11.44
2	96	11.18	95	3.32	32	11.25½	14	99	11.30½	107	3.45	57	11.46
3	110	11.19	107	3.32½	93	11.28	15	97	11.31	97	3.45½	78	11.46½
4	69	11.23	86	3.33	88	11.28½	16	90	11.34	98	3.46	136	11.47
5	103	11.23½	87	3.36	52	11.29	17	98	11.34½	106	3.48	53	11.48
6	103	11.24	107	3.36½	90	11.30	18	100	11.35	102	3.48½	40	11.49
7	75	11.25	85	3.37	69	11.31	19	97	11.40	90	3.49	.....	.....
8	98	11.25½	81	3.40	65	11.38	20	94	11.40½	88	3.52	.....	.....
9	103	11.26	100	3.40½	83	11.38½	21	88	11.41	109	3.52½	.....	.....
10	70	11.27	80	3.41	82	11.39	22	92	11.43	85	3.53	.....	.....
11	102	11.27½	101	3.43	60	11.43	23	67	11.44	83	3.55	.....	.....
12	103	11.28	101	3.43½	83	11.43½	24	20	11.45	93	3.56	.....	.....

[a] Pig iron used from car 27633. [b] Pig iron used from car 131943.

Remarks.—Test 150: Temperature of iron, medium. Test 157: Iron hot. Test 164: Iron cold.

BRIQUETTING TESTS.

Illinois No. 29.

Tests 170 and 171† (coal A, washed screenings).—Size as used: Over ¼ inch, 3.6 per cent; $\frac{1}{10}$ inch to ¼ inch, 8.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 16.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 20.8 per cent; through $\frac{1}{40}$ inch, 50.8 per cent. Satisfactory briquets were made on both machines with 7 per cent binder. Briquets were very hard and tough, and broke with rough fracture and hard edges. Renfrow briquets were well molded and stood handling when warm. For analyses of briquets from test 170 see page 111 (steaming test 465).

Test 175† (coal B, raw, run of mine).—Size as used: Over ¼ inch, 3.2 per cent; $\frac{1}{10}$ inch to ¼ inch, 9.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 16.4 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 25.8 per cent; through $\frac{1}{40}$ inch, 44.8 per cent. The briquets were identical with those made of the washed coal, except that fracture was rougher and harder, as fuel did not crush so fine in grinding. For analyses of briquets from test 175†, see page 111 (steaming test 466).

	A.		B.
	Test 170.	Test 171†.	Test 175†.
Details of manufacture:			
Machine used	Eng.	Renf.	Renf.
Temperature of briquets °F.	203	131	131
Binder—			
Kind	w. g. p. / c. t. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4319 / 4543	4543	4543
Amount per cent.	7	7	7
Weight of—			
Fuel briquetted pounds.	6,000	24,000	15,000
Briquets, average do.	3.84	.437	.465
Heat value per pound—			
Fuel as received B. t. u.	11,844	11,844	10,667
Fuel as fired do.	11,254	11,671	11,486
Binder do.	[a] 16,554	16,969	16,969
Drop test (1-inch screen):			
Held per cent.	74.4	47.0	50.5
Passed do.	25.6	53.0	49.5
Tumbler test (1-inch screen):			
Held per cent.	94.0	75.0	77.5
Passed (fines) do.	.06	25.0	22.5
Fines through 10-mesh sieve do.	81.2	87.3	90.2
Weathering test:			
Time exposed days.	56	55	53
Condition	C.	B.	B.
Water absorption:			
In 19 days per cent.	17.0	21.5	18.8
Average for first—			
2 days do.	5.15	5.05	.....
5 days do.	.....	.....	2.42
Specific gravity (apparent)	1.053	.969	1.042

[a] Equal weights of two pitches were used and the calorific value determined from the separate calorific values of these pitches.

Extraction analyses.

	Pitches.		A.			B.	
			Fuel.	Briquets.		Fuel.	Briquets, test 175†.
				Test 170.	Test 171†.		
Laboratory No.	4319	4543	3963	4233	4581	3958	4245
Air-drying loss.....per cent.	.....	.....	8.60	11.80	10.40	7.30	7.80
Extracted by CS_2:							
Air-dried.....do.	.....	.....	.83	6.61	7.57	.99	6.92
As received.....do.	66.25	99.66	.76	5.83	6.77	.92	6.38
Pitch in briquets, as received, per cent	.....	.....	.....	6.17	6.09	.....	5.53

ILLINOIS NO. 30.

Bituminous coal from bed No. 7 at Shiloh station, St. Clair County, on the Southern Railway, was designated Illinois No. 30. The coal as worked at a depth of 126 feet at this place averages 6 feet 8 inches in thickness.

One sample, shipped under the supervision of K. M. Way, consisted of nut coal through a 3-inch and over a 2-inch shaking screen, and was used in steaming test 511 (on briquets); producer-gas test 157; washing tests 190 and 190a; and briquetting tests 225, 226, and 228.

Two mine samples were taken for chemical analysis. Sample 3910 was taken 900 feet southwest of the shaft, where the coal measured 6 feet 9 inches in thickness. Sample 3912 was taken 800 feet northeast of the shaft, where the coal measured 6 feet 8 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 30.

	Mine samples.		Car sample.	Steaming test 511.[a]
Laboratory No.	3910	3912	4364	4714
Air-drying loss	2.30	.....	8.70	.....
Proximate:				
Moisture	10.73	9.88	11.69	9.75
Volatile matter	39.60	42.26	35.70	39.25
Fixed carbon	40.41	37.05	39.42	42.69
Ash	9.26	10.81	13.19	8.13
Sulphur	4.12	3.83	4.38	3.21
Ultimate:				
Hydrogen	.....	.....	5.46	4.80
Carbon	.....	.....	57.15	71.76
Nitrogen	.....	.....	.94	1.13
Oxygen	.....	.....	18.88	9.60
Ash	.....	.....	.....	9.21
Sulphur	.....	.....	.....	3.56
Calorific value determined (as received) calories	.....	6,355	5,944	.....
Calorific value determined (as received) B. t. u	.....	11,439	10,699	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Illinois No. 30 (washed).

	Test 511.
Duration of test.....hours..	8.58
Heating value of fuel.....B. t. u. per pound dry fuel..	13,271
Force of draft:	
Under stack damper.....inch water..	0.87
Above fire.....do....	.19
Dry fuel used per square foot of grate surface per hour.....pounds..	20.94
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	3.59
Percentage of rated horsepower of boiler developed.....	100.7
Water apparently evaporated per pound of fuel as fired.....pounds..	6.41
Water evaporated from and at 212° F.:	
Per pound of fuel as fired.....do....	7.76
Per pound of dry fuel.....do....	8.60
Per pound of combustible.....do....	9.59
Efficiency of boiler, including grate.....per cent..	62.58
Fuel as fired:	
Per indicated horsepower hour.....pounds..	3.64
Per electrical horsepower hour.....do....	4.50
Dry fuel:	
Per indicated horsepower hour.....do....	3.29
Per electrical horsepower hour.....do....	4.06

Remarks.—Test made on English briquets from tests 225 and 226 (equal parts). Fuel burned slowly with hot fire, medium flame, and no smoke; 40 per cent clinker.

PRODUCER-GAS TEST.

Illinois No. 30 (washed).

Test 157.—Duration of test, 50 hours. Average electrical horsepower, 199; average B. t. u. per cubic foot of gas, 154.4; total coal fired, 16,200 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.69	1.60	1.44
Developed at switch board	1.63	1.54	1.38
Per brake horsepower:			
Commercially available	1.44	1.36	1.22
Developed at engine	1.38	1.31	1.17
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.78	1.68	1.51
Developed at switch board	1.71	1.61	1.45
Per brake horsepower:			
Commercially available	1.51	1.43	1.28
Developed at engine	1.45	1.37	1.23

Analyses.

Coal.		*Gas by volume.*	
Moisture	5.59	Carbon dioxide (CO_2)	9.3
Volatile matter	39.30	Carbon monoxide (CO)	19.6
Fixed carbon	45.45	Hydrogen (H_2)	13.8
Ash	9.66	Methane (CH_4)	2.0
Sulphur	3.37	Nitrogen (N_2)	54.7
		Ethylene (C_2H_4)	.6

WASHING TESTS.

Illinois No. 30.

	Test 190.	Test 190a.		Test 190.	Test 190a.
Duration of test.....hours..	2	4	Raw coal.....tons..	15	12.45
Size as used..through screen.	2½-inch.	1-inch.	Washed coal.....do....	11.60	10.1
Jig adjustment:			Washed coal.....per cent..	77	81
Make or number.....	Stewart.	Special.	Refuse.....tons.....	3.40	2.35
Speed.....r. p. m..	35	70	Refuse.....per cent..	23	19
Stroke.....inches..	6	2½			

Analyses.

Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur.	
			Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
Raw coal, car sample.....	4364	11.69	13.19	.....	4.38	.....
Washed coal.....test 190..	4379	12.36	9.44	28.3	3.26	25.6
Washed coal.....test 190a..	4621	13.67	7.89	40	3.15	28
Refuse, test 190a.....	.....	11.22	46.50	.....	9.59	.....

Float and sink tests.

No. of test.	Size used (inch).	Specific gravity of solution used.	Percentage of float—		Sink (per cent).	Analyses.			
			To refuse.	To total sample.		Ash.		Sulphur.	
						Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
On raw coal (preliminary):									
1.....	1¼	1.36	.....	73	27	7.10	46	3.29	23
2.....	1¼	1.41	.....	84	16	8.69	34	3.29	23
3.....	1¼	1.47	.....	88	12	8.98	31	3.33	23
4.....	1¼	1.56	.....	90	10	9.59	27	3.41	22
On refuse (float)[a] of test 190a									
1.....	.....	1.36	15.8	2.98	.....	8.00	.....	3.12	.....
2.....	.....	1.40	20.18	4.13	.....	11.30	.....	3.42	.....
3.....	.....	1.45	29.90	5.63	.....	12.00	.....	3.43	.....
4.....	.....	1.51	33.50	6.31	.....	14.60	.....	4.63	.....

[a] Loss of good coal 2.98 per cent.

BRIQUETTING TESTS.

Illinois No. 30 (nut, washed).

Tests 225, 226, 228.—Size as used: Over ¼ inch, 2 per cent; $\frac{1}{10}$ inch to ¼ inch, 7 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 17.4 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 20.8 per cent; through $\frac{1}{40}$ inch, 52.8 per cent. Briquets satisfactory; had a hard, rough exterior and broke with a rough, uneven fracture, with crumbly edges. All briquets had a bluish color and fracture, which showed an excess of pitch. The Renfrow briquets showed insufficient pressure. For analysis of briquets from tests 225 and 226 see page 115 (steaming test 511).

	Test 225.	Test 226.	Test 228.
Details of manufacture:			
Machine used	Eng.	Eng.	Renf.
Temperature of briquettes, °F.	185	185	158
Binder—			
Kind	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4806	4806	4806
Amount, per cent.	6	7	8.5
Weight of—			
Fuel briquetted, pounds.	6,000	6,000	6,500
Briquets, average, do.	3.50	3.45	0.463
Heat value per pound—			
Fuel as received, B. t. u.	11,921	11,921	11,921
Fuel as fired, do.	11,977	11,977	(a)
Binder, do.	16,864	16,864	16,864
Drop test (1-inch screen):			
Held, per cent.	80.2	81.5	47.0
Passed, do.	19.8	18.5	53.0
Tumbler test 1-inch screen):			
Held, do.	75.9	79.0	82.5
Passed (fines), do.	24.1	21.0	17.5
Fines through 10-mesh sieve, do.	82.6	85.0	95.0
Water absorption:			
In 13 days, do.	8.6	8.5	.....
In 23 days, do.	.....	.....	16.2
Average for first 5 days, do.	1.35	1.98	2.10
Specific gravity (apparent)	1.087	1.080	1.060

[a] No test.

Extraction analyses.

	Pitch.	Fuel.	Briquets, tests 225, 226.
Laboratory No.	4806	4364	4714
Air-drying loss, per cent.	.....	8.70	5.30
Extracted by CS_2:			
Air-dried, do.	.....	.65	6.53
As received, do.	96.90	.61	6.18
Pitch in briquets, as received, do.	.....	.....	5.80

ILLINOIS NO. 31.

Bituminous coal from bed No. 6 at Warden, St. Clair County, on the Wabash Railroad, was designated Illinois No. 31. The coal, as worked at a depth of 300 feet at this place, averages 6 feet 8 inches in thickness.

One sample, shipped under the supervision of K. M. Way, consisted of screenings over a 1¼-inch shaking screen, and was used in steaming tests (on briquets) 489 and 491, and briquetting tests 185, 186, 224†, and 237†.

Two mine samples were taken for chemical analysis. Sample 4250 was taken 1,000 feet southwest of the shaft, where the coal measured 5 feet 10¾ inches in thickness. Sample 4251 was taken 1,600 feet north of the shaft, where the coal measured 7 feet 5¾ inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 31.

	Mine samples.		Car sample.	Steaming tests.[a]		Briquetting tests.[b]	
				489.	491.	224†.	237†.
Laboratory No	4250	4251	4376	4382	4397	.....	.....
Air-drying loss	8.00	9.40	9.70	.....	.....	.....	.....
Proximate:							
Moisture	13.17	14.38	13.10	14.52	10.81	9.17	6.98
Volatile matter	34.79	33.92	32.16	33.74	33.72	33.03	35.21
Fixed carbon	41.75	42.95	41.49	39.40	42.74	43.90	42.85
Ash	10.29	8.75	13.25	12.34	12.73	13.90	14.96
Sulphur	3.22	3.13	3.66	3.36	3.50	3.90	3.78
Ultimate:							
Hydrogen	.....	.....	5.44	4.68	4.54	4.33	3.57
Carbon	.....	.....	57.31	67.91	67.31	66.14	59.48
Nitrogen	.....	.....	1.03	1.12	1.04	1.01	.83
Oxygen	.....	.....	19.31	7.92	8.92	8.93	5.67
Ash	.....	.....	.....	14.44	14.27	15.30	25.03
Sulphur	.....	.....	.....	3.93	3.92	4.29	5.42
Calorific value determined (as received)	calories.	6,032	5,774	.....	.....	.....	.....
	B. t. u.	10,858	10,363	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Illinois No. 31 (briquets).

	Test 489.	Test 491.
Duration of test ..... hours.	9.47	9.75
Heating value of fuel ..... B. t. u. per pound dry fuel.	12,303	12,335
Force of draft:		
Under stack damper ..... inch water.	0.74	0.87
Above fire ..... do.	.14	.20
Dry fuel used per square foot of grate surface per hour ..... pounds.	21.16	21.65
Equivalent water evaporated per square foot of water-heating surface per hour ..... pounds.	3.49	3.56
Percentage of rated horsepower of boiler developed	97.7	100.0
Water apparently evaporated per pound of fuel as fired ..... pounds.	5.84	6.09
Water evaporated from and at 212° F.:		
Per pound of fuel as fired ..... pounds.	7.06	7.35
Per pound of dry fuel ..... do.	8.25	8.24
Per pound of combustible ..... do.	9.81	9.77
Efficiency of boiler, including grate ..... per cent.	64.76	64.51
Fuel as fired:		
Per indicated horsepower hour ..... pounds.	4.01	3.85
Per electrical horsepower hour ..... do.	4.94	4.75
Dry fuel:		
Per indicated horsepower hour ..... do.	3.43	3.43
Per electrical horsepower hour ..... do.	4.23	4.24

Remarks.—Test 489 on briquets from test 186; test 491 on briquets from test 185: Fuel gave good results with thick fire; burned with a medium long flame, and gave 2 per cent black smoke. Renfrow briquets gave 47 per cent and English briquets 45 per cent clinker; brittle, porous, dark-gray color, and did not stick to grates.

BRIQUETTING TESTS.

Illinois No. 31 (screenings).

Tests 185, 186, 224†, 237†.—Size as used: Over $\frac{1}{4}$ inch, 3 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 8.5 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 17 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 24 per cent; through $\frac{1}{40}$ inch, 47.5 per cent. Briquets were porous, with soft surfaces, rough fracture, and easily crumbled edges. English briquets were handled from ma-

chine without breaking. Renfrow briquets were not satisfactory, owing to low pressure. This should be a good briquetting coal, although dirty. For analyses of briquets see page 119 (briquets from test 185 under "Steaming test 491," from test 186 under "Steaming test 489)."

	Test 185.	Test 186.	Test 224†.	Test 237†.
Details of manufacture:				
Machine used	Renf.	Eng.	Eng.	Renf.
Temperature of briquets, °F.	140	176	149	149
Binder—				
Kind	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4543	4543	4683	4806
Amount, per cent.	7	7	7	8
Weight of—				
Fuel briquetted, pounds.	12,000	12,000	11,600	10,000
Briquets, average, do.	0.460	3.77	3.91	0.442
Heat value per pound—				
Fuel as received, B. t. u.	10,393	10,393	10,393	10,393
Fuel as fired, do.	10,012	10,517	10,921	11,158
Binder, do.	16,969	16,969	16,637	16,864
Drop test (1-inch screen):				
Held, per cent.	64.5	79.7	24.2	34.5
Passed, do.	35.5	20.3	75.8	65.5
Tumbler test (1-inch screen):				
Held, do.	91.5	78.8	43.3	80.5
Passed (fines), do.	8.5	21.2	56.7	19.5
Fines through 10-mesh sieve, do.	94.1	75.7	65.0	87.5
Weathering test:				
Time exposed, days.	11	10	.....	.....
Condition	B.	A.	.....	.....
Water absorption:				
In 19 days, per cent.	14.5	9.2	.....	.....
In 13 days, do.	.....	.....	7.4	13.1
Average for first 3 days, do.	2.70	1.60	1.67	1.93
Specific gravity (apparent)	1.053	1.144	1.167	1.123

Extraction analyses.

	Pitches.			Fuel.	Briquets.			
					Test 185.	Test 186.	Test 224†.	Test 237†.
Laboratory No.	4543	4683	4806	4376	4397	4382	4830	4890
Air-drying loss, per cent.	.....	.....	.....	9.70	8.00	11.10	4.70	2.80
Extracted by CS_2:								
Air dried, do.	.....	.....	.....	.49	7.07	6.99	7.05	7.80
As received, do.	99.66	89.31	96.90	.44	6.50	6.21	6.72	7.58
Pitch in briquets, as received, do.	.....	.....	.....	.....	6.11	5.86	7.08	7.41

ILLINOIS NO. 33.

Bituminous coal from bed No. 7 at Trenton, Clinton County, on the Baltimore and Ohio Railroad, was designated Illinois No. 33. This coal, as worked at a depth of 320 feet at this place, averages 5 feet 3 inches in thickness.

One sample, shipped under the supervision of K. M. Way, consisted of screenings through a 1½-inch shaking screen, and was used in steaming test 513 and briquetting tests 206, 207, 210, and 235†.

Two mine samples were taken for chemical analysis. Sample 4384 was taken 1,800 feet west of the shaft, where the coal measured 5 feet 6 inches in thickness. Sample 4385 was taken 2,000 feet northwest of the shaft, where the coal measured 5 feet in thickness.

CHEMICAL ANALYSES.

Illinois No. 33.

	Mine samples.		Steaming test 513.[a]	Briquetting test 235†.[b]
Laboratory No.	4384	4385	4728	4888
Air-drying loss	4.70	4.80	.....	3.90
Proximate:				
Moisture	14.45	15.06	11.50	9.47
Volatile matter	29.76	29.48	25.44	28.25
Fixed carbon	46.16	45.81	42.37	40.75
Ash	9.63	9.65	20.69	21.53
Sulphur	2.09	1.05	1.52	1.56
Ultimate:				
Hydrogen	.....	.....	3.72	3.93
Carbon	.....	.....	61.46	60.07
Nitrogen	.....	.....	1.02	1.03
Oxygen	.....	.....	8.70	9.47
Ash	.....	.....	23.38	23.78
Sulphur	.....	.....	1.72	1.72
Calorific value determined (as received) calories	.....	5,959	.....	5,423
Calorific value determined (as received) B. t. u.	.....	10,726	.....	9,761

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car samples.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TEST.

Illinois No. 33 (screenings).

	Test 513.[a]
Duration of test, hours	8.68
Heating value of fuel, B. t. u. per pound dry fuel	11,099
Force of draft:	
Under stack damper, inches water	1.01
Above fire, do	.10
In ash pit (forced draft)	.34
Furnace temperature, °F.	2,465
Dry coal used per square foot of grate surface per hour, pounds	26.41
Equivalent water evaporated per square foot of water-heating surface per hour, do	3.23
Percentage of rated horsepower of boiler developed	90.7
Water apparently evaporated per pound of coal as fired, pounds	4.49
Water evaporated from and at 212° F.:	
Per pound of fuel as fired, do	5.43
Per pound of dry fuel, do	6.13
Per pound of combustible, do	8.53
Efficiency of boiler, including grate, per cent	53.34
Fuel as fired:	
Per indicated horsepower hour, pounds	5.21
Per electrical horsepower hour, do	6.43
Dry fuel:	
Per indicated horsepower hour, do	4.61
Per electrical horsepower hour, do	5.69

[a] On English briquets.

BRIQUETTING TESTS.

Illinois No. 33 (screenings).

Tests 206, 207, 210, 235†.—Size as used: Over $\frac{1}{4}$ inch, 2.0 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 9.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 26.4 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 27.0 per cent; through $\frac{1}{40}$ inch, 34.8 per cent. The surface of all briquets was soft, fracture ragged, and edges easily broken. Greater percentage of binder had no apparent effect on appearance. Increased moisture content made a very soft, warm briquet, which hardened on cooling with a harder surface than those with less moisture. For analyses of briquets see above (briquets from tests 206 and 207 under "Steaming test 513").

	Test 206.	Test 207.	Test 210.	Test 235†.
Details of manufacture:				
Machine used	Eng.	Eng.	Renf.	Renf.
Temperature of briquets, °F.	149	149	158	167
Binder—				
Kind	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4683	4683	4683	4806
Amount, per cent.	7	6	7	8
Weight of—				
Fuel briquetted, pounds.	8,000	7,000	6,000	15,000
Briquets, average, do.	4.07	4.12	0.474	0.484
Heat value per pound—				
Fuel as received, B. t. u.	7,634	7,634	7,634	7,634
Fuel as fired, do.	9,823	9,823	(a)	9,761
Binder, do.	16,637	16,637	16,637	16,864
Drop test (1-inch screen):				
Held, per cent.	50.0	61.8	74.5	34.5
Passed, do.	50.0	38.2	25.5	65.5
Tumbler test (1-inch screen):				
Held, do.	55.6	60.3	94.0	89.5
Passed (fines), do.	44.4	39.7	6.0	10.5
Fines through 10-mesh sieve, do.	66.6	72.1	90.8	94.7
Water absorption:				
In 10 days, do.	7.6	9.4	11.1	6.5
Average for first 3 days, do.	2.3	2.40	2.93	1.70
Specific gravity (apparent)	1.291	1.280	1.232	1.298

(a) No test.

Extraction analyses.

	Pitches.		Fuel.	Briquets.	
				Test 206.	Test 235†.
Laboratory No.	4683	4806	4385	4728	4888
Air-drying loss, per cent.			4.80	5.50	3.90
Extracted by CS_2:					
Air-dried, do.			0.29	5.22	7.66
As received, do.	80.31	96.90	0.28	4.93	7.42
Pitch in briquets, as received, do.				5.23	7.40

ILLINOIS NO. 34.

Bituminous coal from bed No. 5 at Harrisburg, Saline County, on the Big Four System, was designated Illinois No. 34. The coal, as worked at a depth of 165 feet at this place, averages 7 feet 1 inch in thickness.

Two samples were shipped under the supervision of K. M. Way, as follows: Illinois No. 34 A consisted of screenings over a $1\frac{1}{4}$-inch shaking screen, and was used in washing test 196. Illinois No. 34 B consisted of run-of-mine coal, and was used in steaming test 509, washing test 197, and coking test 190.

Two mine samples were taken for chemical analysis. Sample 4413 was taken 2,000 feet southwest of the shaft, where the coal measured 7 feet 3 inches in thickness. Sample 4414 was taken 1,000 feet north of the shaft, where the coal measured 6 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Illinois No. 34.

	Mine samples.		Car samples.		Steaming test 509.[a]
			A.	B.	
Laboratory No	4413	4414	4636	4622	.....
Air-drying loss	4.20	.....	6.60	5.80	.....
Proximate:					
Moisture	7.55	7.51	9.33	7.81	6.56
Volatile matter	33.85	32.81	30.92	33.54	34.15
Fixed carbon	51.45	52.20	47.86	50.27	51.57
Ash	7.15	7.48	11.89	8.38	7.72
Sulphur	1.56	1.58	2.76	2.36	2.17
Ultimate:					
Hydrogen	.....	.....	5.12	5.31	4.87
Carbon	.....	.....	62.85	67.40	74.00
Nitrogen	.....	.....	1.29	1.44	1.58
Oxygen	.....	.....	16.09	15.11	8.98
Ash	.....	.....	.....	.....	8.26
Sulphur	.....	.....	.....	.....	2.31
Calorific value determined (as received). calories	.....	7,048	6,429	6,899	.....
Calorific value determined (as received). B. t. u.	.....	12,686	11,572	12,418	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Illinois No. 34 B (run of mine).

	Test 509.
Size as used:	
Over 1 inch ..... per cent	44.3
½ inch to 1 inch ..... do	22.8
¼ inch to ½ inch ..... do	13.4
Under ¼ inch ..... do	19.5
Average diameter ..... inches	1.23
Duration of test ..... hours	9.00
Heating value of coal ..... B. t. u. per pound dry coal	13,621
Force of draft:	
Under stack damper ..... inch water	0.83
Above fire ..... do	.22
Dry coal used per square foot of grate surface per hour ..... pounds	21.50
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	3.79
Percentage of rated horsepower of boiler developed	106.2
Water apparently evaporated per pound of coal as fired ..... pounds	6.80
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... do	8.24
Per pound of dry coal ..... do	8.82
Per pound of combustible ..... do	9.79
Efficiency of boiler, including grate ..... per cent	62.53
Coal as fired:	
Per indicated horsepower hour ..... pounds	3.43
Per electrical horsepower hour ..... do	4.24
Dry coal:	
Per indicated horsepower hour ..... do	3.21
Per electrical horsepower hour ..... do	3.96

WASHING TESTS.

Illinois No. 34.

	Test 196 (A).	Test 197 (B).		Test 196 (A).	Test 197 (B).
Duration of test ..... hours	4¼	2	Raw coal ..... tons	24.65	14
Size as used through screen	1 inch.	1 inch.	Washed coal ..... do	19.55	11.81
Jig adjustment:			Washed coal ..... per cent	80	85
Make or number	Special.	Special.	Refuse ..... tons	5.10	2.19
Speed ..... p. m.	70	70	Refuse ..... per cent	20	15
Stroke ..... inches	2½	2½			

Analyses.

	Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur.	
				Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
A	Raw coal, car sample	4636	9.33	11.89		2.76	
A	Washed coal, test 196	4709	8.68	77.44	37	2.19	21
A	Refuse		9.29	58.43		11.91	
B	Raw coal, car sample	4622	7.81	8.38		2.36	
B	Washed coal, test 197	4628	10.12	6.52	21	1.76	26
B	Refuse		15.35	61.00		15.90	

Float and sink tests.

	No. of test.	Size used (inch).	Specific gravity of solution used.	Percentage of float—		Sink (per cent).	Analyses.			
				To refuse.	To total sample.		Ash.		Sulphur.	
							Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
On raw coal (preliminary):										
A	1	3/4	1.36		84	16	6.07	49	1.90	31
A	2	3/4	1.41		88	12	6.12	48	1.83	34
A	3	3/4	1.45		90	10	7.06	41	2.18	21
A	4	3/4	1.51		92	8	7.10	40	1.97	29
B	1	1	1.35		87	13	5.91	29	1.71	28
B	2	1	1.41		90	10	6.15	27	1.64	31
B	3	1	1.46		92	8	6.20	26	1.68	29
B	4	1	1.51		92	8	7.23	14	2.17	8
On refuse (float):										
A[a]	1		1.35	12.10	2.52		6.95		2.05	
A[a]	2		1.41	13.59	2.82		7.78		2.33	
A[a]	3		1.45	14.21	2.95		9.58		2.45	
A[a]	4		1.51	16.78	3.43		11.20		3.05	
B[b]	1		1.35	50	7.80		6.27		2.36	
B[b]	2		1.40	52	8.14		5.99		2.50	
B[b]	3		1.45	55	8.60		7.40		2.79	

[a] Loss of good coal, 2.52 per cent.

[b] Figures indicate that finer crushing is advantageous. Loss of "good coal" in the refuse will not exceed 1.75 per cent. By "good coal" is meant all coal of a quality equal to or better than that of the washed coal.

COKING TEST.

Illinois No. 34 B (run of mine).

Test 190.—Size as used, washed, finely crushed. Duration of test, 51 hours. Coal charged, 12,980 pounds. Coke produced, 6,523 pounds; 50.25 per cent. Breeze produced, 316 pounds; 2.43 per cent. Total yield, 52.68 per cent. Coke, light gray and silvery. Yield low on account of burning to obtain heat; could be easily increased on better acquaintance. Good coke, but sulphur a little high.

Analyses.

	Coal.	Coke.
Moisture	9.91	0.19
Volatile matter	33.33	.35
Fixed carbon	50.65	87.91
Ash	6.11	11.55
Sulphur	1.75	1.48

INDIANA.

INDIANA NO. 1.[a]

A sample of bituminous screenings (through 1-inch screen) from Mildred, Sullivan County, on the Evansville and Terre Haute Railroad, was designated Indiana No. 1 B. This sample was used in briquetting test 217*†.

CHEMICAL ANALYSES.

Indiana No. 1 B.

	Briquetting test 217*†.[a]		Briquetting test 217*†.[a]
Proximate:		Ultimate:	
Moisture	8.29	Hydrogen	4.43
Volatile matter	30.55	Carbon	68.76
Fixed carbon	47.01	Nitrogen	1.19
Ash	14.15	Oxygen	7.59
Sulphur	2.38	Ash	15.43
		Sulphur	2.60

[a] Proximate analysis of fuel as received; ultimate analysis on dry basis.

BRIQUETTING TEST.

Indiana No. 1 B (screenings).

Test 217†.*—Size as used: Over $\frac{1}{4}$-inch, 5.0 per cent; $\frac{1}{10}$-inch to $\frac{1}{4}$-inch, 12.4 per cent; $\frac{1}{20}$-inch to $\frac{1}{10}$-inch, 22.4 per cent; $\frac{1}{40}$-inch to $\frac{1}{20}$-inch, 23.4 per cent; through $\frac{1}{40}$-inch, 36.8 per cent. Briquets with 8.5 per cent binder on Renfrew machine satisfactory when fuel was very dry; excess of moisture made a briquet that was soft when warm and crumbled easily when cold. Briquets had a porous, dull surface; rough fracture with ragged edges, but tough and hard, producing a small amount of slack in handling; showed no evidence of sticking together when piled warm.

Details of manufacture:		Drop test (1-inch screen):	
Machine used	Renf.	Held ..... per cent	54.5
Temperature of briquets ..... °F.	141	Passed ..... do	45.5
Binder—		Tumbler test (1-inch screen):	
Kind	w. g. p.	Held ..... do	86.5
Laboratory No. (see p. 40)	4683	Passed (fines) ..... do	13.5
Amount ..... per cent	8.5	Fines through 10-mesh sieve ..... do	95.0
Weight of—		Water absorption:	
Fuel briquetted	88,000	In 22 days ..... do	14.0
Briquets, average ..... per cent	0.485	Average for first 5 days ..... do	1.92
Heat value per pound—		Specific gravity (apparent)	1.114
Fuel as received ..... B. t. u.	9,866		
Fuel as fired ..... do	11,444		
Binder ..... do	16,637		

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 217*†.
Laboratory No.	4683	4590	4680
Air-drying loss ..... per cent	.....	13.90	3.60
Extracted by CS_2:			
Air-dried ..... do	.....	.81	7.35
As received ..... do	89.31	.69	7.08
Pitch in briquets, as received ..... do	.....	.....	7.21

[a] For other tests of fuel from this mine, made during 1904, see Bull. U. S. Geol. Survey No. 261, 1905, pp. 38, 80, 94, 119, 123, and 154; and Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 63, 212, 473, 1068, 1336, 1438, and 1463.

INDIANA NO. 5.[a]

A sample of bituminous screenings (through 1¼-inch bar screen) from Hymera, Sullivan County, on the Evansville and Terre Haute Railroad, was designated Indiana No. 5 B, and was used in briquetting tests 229* and 230*†.

CHEMICAL ANALYSES.

Indiana No. 5 B.

	Briquetting tests.[a]			Briquetting tests.[a]	
	229*.	230*†.		229*.	230*†.
Proximate:			Ultimate:		
Moisture	7.27	6.34	Hydrogen	4.49	4.62
Volatile matter	37.73	37.53	Carbon	68.47	68.06
Fixed carbon	44.37	44.74	Nitrogen	1.13	1.10
Ash	10.63	11.39	Oxygen	9.80	8.96
Sulphur	4.29	4.76	Ash	11.49	12.18
			Sulphur	4.62	5.08

[a] Proximate analysis of fuel as received; ultimate analysis on dry basis.

BRIQUETTING TESTS.

Indiana No. 5 B (screenings).

Tests 229 and 230*†.*—Size as used: Over ¼ inch, 1 per cent; $\frac{1}{10}$ inch to ¼ inch, 5.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 11.8 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 20.4 per cent; through $\frac{1}{40}$ inch, 61.2 per cent. The briquets were identical in character with those made from Indiana No. 1 B (p. 125) and Indiana No. 6 B (p. 127).

	Test 229*.	Test 230*†.		Test 229*.	Test 230*†.
Details of manufacture:			Details of manufacture—Con.		
Machine used	Eng.	Renf.	Heat value per pound—Con.		
Temperature of briquets, °F	176	140	Binder B. t. u.	16,864	16,864
Binder—			Drop test (1-inch screen):		
Kind	w. g. p.	w. g. p.	Held per cent.	81.6	50.0
Laboratory No. (see p. 40)	4806	4806	Passed do.	18.4	50.0
Amount per cent.	7	9	Tumbler test (1-inch screen):		
Weight of—			Held per cent.	79.3	81.5
Fuel briquetted, pounds	24,000	30,000	Passed (fines) do.	20.7	18.5
Briquets, average, pounds	3.69	0.424	Fines through 10-mesh sieve per cent.	72.5	92.3
Heat value per pound—			Water absorption:		
Fuel as received, B. t. u.	10,822	10,822	In 13 days do.	7.4	.....
Fuel as fired. B. t. u.	11,945	12,046	In 23 days do.	.....	13.8
			Average for first 5 days, per cent	1.20	1.86
			Specific gravity (apparent)	1.078	1.097

Extraction analyses.

	Pitch.	Fuel.	Briquets.	
			Test 229*.	Test 230*†.
Laboratory No.	4806	4708	4822	.....
Air-drying loss per cent.	.....	10.00	.....	.....
Extracted by CS_2:				
Air-dried do.	.....	1.46	.....	.....
As received do.	96.90	1.31	6.87	8.50
Pitch in briquets, as received do.	.....	.....	5.82	7.52

[a] For other tests of coal from this mine, made during 1905, see Bull. U. S. Geol. Survey No. 290, 1906, pp. 100–102.

INDIANA NO. 6.[a]

Bituminous screenings (through 1¼-inch bar screen) from vein No. 4 at Hymera, Sullivan County, on the Evansville and Terre Haute Railroad, were designated Indiana No. 6 B, shipped uninspected, and used in briquetting tests 220* and 227†.

CHEMICAL ANALYSES.

Indiana No. 6 B.

	Briquetting tests.[a]			Briquetting tests.[a]	
	220*.	227†.		220*.	227†.
Proximate:			Ultimate:		
Moisture	5.84	5.72	Hydrogen	5.04	4.76
Volatile matter	38.08	37.83	Carbon	70.61	66.48
Fixed carbon	44.22	43.16	Nitrogen	1.14	1.07
Ash	11.86	13.29	Oxygen	5.85	8.42
Sulphur	4.49	4.87	Ash	12.59	14.10
			Sulphur	4.77	5.17

[a] Proximate analysis of fuel as received; ultimate analysis on dry basis.

BRIQUETTING TESTS.

Indiana No. 6 B (screenings).

Tests 220, 227†.*—Size as used: Over ¼-inch, 1.2 per cent; $\frac{1}{10}$-inch to ¼-inch, 5.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 10.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 20.4 per cent; through $\frac{1}{40}$ inch, 62.6 per cent. Renfrow briquets were similar to those made from Indiana 1 B coal. Seven per cent binder gave satisfactory English briquets when coal was thoroughly dried; otherwise briquets were soft and easily broken when cold. Briquets were soft and spongy when warm, although cohesive enough to be handled without breaking. When cold they became tough with porous surfaces, rough fractures, and ragged edges.

	Test 220*.	Test 227†.		Test 220*.	Test 227†.
Details of manufacture:			Details of manufacture—Con.		
Machine used	Renf.	Eng.	Heat value per pound—Con.		
Temperature of briquets, °F	140	168	Binder B. t. u.	16,864	16,864
Binder—			Drop test (1-inch screen):		
Kind	w. g. p.	w. g. p.	Held per cent.	58.5	83.7
Laboratory No. (see p. 40)	4806	4806	Passed per cent.	41.5	16.3
Amount per cent.	8.5	7	Tumbler test (1-inch screen):		
Weight of—			Held per cent.	84.0	81.2
Fuel briquetted, pounds	64,000	8,000	Passed (fines) do.	16.0	18.8
Briquets, average, pounds	0.484	3.84	Fines through 10-mesh sieve per cent.	90.0	78.3
Heat value per pound—			Water absorption:		
Fuel as received, B. t. u.	10,987	10,987	In 13 days do.	12.5	6.7
Fuel as fired. B. t. u.	12,132	11,839	Average for first 5 days, per cent.	2.04	1.06
			Specific gravity (apparent)	1.083	1.156

[a] For other tests of coal from this mine, made during 1905, see Bull. U. S. Geol. Survey No. 290, 1906, pp. 102-105.

Extraction analyses.

	Pitch.	Fuel.	Briquets.	
			Test 220*.	Test 227†.
Laboratory No.	4806	4604	4835	4872
Air-drying loss.....per cent..	.....	7.00	3.30	2.70
Extracted by CS_2:				
Air-dried.....do....	.....	.82	8.38	7.68
As received.....do....	96.90	.76	8.10	7.47
Pitch in briquets, as received.....do....	.....	.....	7.64	6.99

INDIANA NO. 12.

Bituminous coal from Hartwell, Pike County, on the Southern Railway, was designated Indiana No. 12. The coal, as worked from the outcrop at this place, averages 4 feet 10 inches in thickness.

This sample, shipped under the supervision of W. J. Von Borries, consisted of run-of-mine coal, and was used in making steaming tests 299, 300, and 310 (on washed coal); producer-gas test 99; washing test 145; coking tests 108 (raw), 109 (washed), and 110 (washed); and cupola test 121 (washed coal).

Two mine samples were taken for chemical analysis. Sample 2701 was taken 1,200 feet nothwest of the opening, where the coal measured 4 feet 9 inches in thickness. Sample 2702 was taken 900 feet northwest of the opening, where the coal measured 5 feet in thickness.

CHEMICAL ANALYSES.

Indiana No. 12.

	Mine samples.		Car samples.		Steaming tests.[a]		
					299.	300.	310.
Laboratory number	2701	2702	2759	2825	.....	.....	.....
Air-drying loss	8.20	8.50	6.40	11.00	.....	.....	.....
Proximate:							
Moisture	11.29	11.10	10.57	12.99	12.81	12.41	12.87
Volatile matter	38.35	37.11	35.03	34.27	33.48	34.12	35.85
Fixed carbon	43.49	43.27	42.75	40.55	39.63	39.61	43.34
Ash	6.87	8.52	11.65	12.19	14.08	13.86	7.94
Sulphur	3.09	3.86	3.87	3.97	3.84	4.21	3.02
Ultimate:							
Hydrogen	.....	.....	5.40	.....	4.54	4.54	5.00
Carbon	.....	.....	61.11	.....	65.66	65.61	72.27
Nitrogen	.....	.....	1.17	.....	1.26	1.26	1.39
Oxygen	.....	.....	16.80	.....	7.99	7.96	8.76
Ash	.....	.....	.....	.....	16.15	15.82	9.11
Sulphur	.....	.....	.....	.....	4.40	4.81	3.47
Calorific value (as received):							
Determined.....calories..	6,623	.....	6,259	.....	.....	.....	.....
Determined.....B. t. u...	11,921	.....	11,266	.....	.....	.....	.....
Calculated from ultimate analysis.....calories..	.....	.....	6,161	.....	.....	.....	.....
Calculated from ultimate analysis.....B. t. u...	.....	.....	11,090	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Indiana No. 12 (run of mine).

	Test 299.	Test 300.	Test 310 (w.).
Size as used:			
Over 1 inch....per cent..	27.5	30.5	28.9
½ inch to 1 inch....do....	21.8	24.3	24.8
¼ inch to ½ inch....do....	18.3	18.9	23.6
Under ¼ inch....do....	32.4	26.3	22.7
Duration of test....hours..	10.08	10.05	9.48
Kind of grate....	Rocking.	Rocking.	.....
Heating value of coal....B. t. u. per pound dry coal..	12,116	12,130	13,271
Force of draft:			
Under stack damper....inch water..	0.50	0.54	0.49
Above fire....do....	.16	.19	.11
Furnace temperature....°F..	2,359	2,397	2,722
Dry coal used per square foot of grate surface per hour....pounds..	22.99	25.13	19.04
Equivalent water evaporated per square foot of water-heating surface per hour....pounds..	3.32	3.71	3.49
Percentage of rated horsepower of boiler developed....	93.1	103.9	97.8
Water apparently evaporated per pound of coal as fired....pounds..	5.85	5.99	6.69
Water evaporated from and at 212° F.:			
Per pound of coal as fired....do....	7.02	7.20	8.00
Per pound of dry coal....do....	8.05	8.22	9.18
Per pound of combustible....do....	9.78	10.02	10.29
Efficiency of boiler, including grate....per cent..	64.16	65.44	66.80
Coal as fired:			
Per indicated horsepower hour....pounds..	4.03	3.93	3.53
Per electrical horsepower hour....do....	4.97	4.85	4.36
Dry coal:			
Per indicated horsepower hour....do....	3.51	3.44	3.08
Per electrical horsepower hour....do....	4.34	4.25	3.80

PRODUCER-GAS TEST.

Indiana No. 12 (run of mine).

Test 99.—Size as used: Over 1 inch, 47 per cent; ½ inch to 1 inch, 23 per cent; ¼ inch to ½ inch, 12 per cent; under ¼ inch, 18 per cent. Duration of test, 50 hours; average electrical horsepower, 194.4; average B. t. u. per cubic foot of gas, 149.4; total coal fired, 17,200 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available....	1.86	1.66	1.43
Developed at switch board....	1.77	1.59	1.36
Per brake horsepower:			
Commercially available....	1.58	1.41	1.22
Developed at engine....	1.50	1.35	1.16
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available....	1.97	1.76	1.52
Developed at switch board....	1.87	1.68	1.44
Per brake horsepower:			
Commercially available....	1.67	1.50	1.29
Developed at engine....	1.59	1.43	1.23

Analyses.

Coal.		*Gas by volume.*	
Moisture....	10.42	Carbon dioxide (CO_2)....	9.0
Volatile matter....	36.29	Carbon monoxide (CO)....	19.0
Fixed carbon....	40.75	Hydrogen (H_2)....	13.0
Ash....	12.54	Methane (CH_4)....	2.0
Sulphur....	3.96	Nitrogen (N_2)....	56.0
		Eithylene (C_2H_4)....	1.0

WASHING AND COKING TESTS.

Indiana No. 12 (run of mine).

Washing test 145.—Size as used, crushed to 2-inch. Jig used, Stewart. Raw coal, 40,000 pounds; washed coal, 35,060 pounds; refuse, 4,940 pounds.

Coking tests.

	Test 108 (raw).	Test 109 (w.).	Test 110 (w.).
Size as used	f. c.	f. c.	r. o. m.
Duration of test, hours	37	35	44
Coal charged, pounds	10,000	10,000	12,000
Coke produced, do	5,258	5,304	6,355
Coke produced, per cent	52.58	53.04	52.96
Breeze produced, pounds	464	255	296
Breeze produced, per cent	4.64	2.55	2.47
Total yield, do	57.22	55.59	55.43

Remarks.—Test 108: Light-gray color; some little silvery; breakage, good-sized pieces; cell structure rather large; high ash and sulphur Test 109: Light gray and silvery; better than coke from raw coal; breakage, good-sized pieces; cell structure rather large; good weight; sulphur not much reduced by washing. Test 110: Light gray and silvery; practically same as test 109; breakage little better, larger size; cell structure not quite so large; good weight coke; sulphur not materially reduced by washing.

Analyses.

	Washing test 145.		Coking test 108.		Coking test 109.		Coking test 110.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	10.57	14.16	11.77	0.88	13.79	0.60	12.82	0.42
Volatile matter	35.03	.....	33.78	0.62	35.43	1.15	37.25	1.03
Fixed carbon	42.75	.....	40.00	75.95	42.75	84.32	41.52	84.37
Ash	11.65	7.85	14.45	22.55	8.03	13.93	8.41	14.18
Sulphur	3.87	3.29	4.32	3.84	3.22	2.86	3.33	2.89

Cupola test of coke made from Indiana No. 12 coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Material.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
121	110	1.87	7	96.53	Coke	180	63	63	62	62	430
					Pig iron	540	428	428	427	427	2,250
					Scrap	180	143	143	142	142	750

[a] Sulphur in ash, 0.06 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure: On at—	Blast pressure: Maximum.	Iron running in—	Weight of iron. Poured.	Additional melted.	Total.	Melting. Time.	Rate per hour.	Ratio iron to coke.	Loss.	Recovered. Iron.	Coke.
		Oz.	Mn.	Lbs.	Lbs.	Lbs.	Min.	Lbs.		Per ct.	Lbs.	Lbs.
121	10.42 a. m.	7	12	1,752	199	1,951	25	4,682	5.48	6.57	852	74

Cupola test of coke made from Indiana No. 12 coal (washed)—Continued.

LADLE RECORD.

Ladle No.	Test 121.		Ladle No.	Test 121.	
	Pounds.	Time (a. m.).		Pounds.	Time (a. m.).
1	80	10.57	12	76	11.09
2	77	10.58	13	106	11.10
3	110	10.59	14	100	11.10½
4	60	11.02	15	32	11.11
5	83	11.02½	16	102	11.13
6	58	11.03	17	96	11.13½
7	106	11.05	18	49	11.14
8	95	11.05½	19	24	11.15
9	57	11.06	20	27	11.16
10	99	11.08	21	94	11.18
11	95	11.08½	22	126	11.19

Remarks.—Test 121: Iron dull.

INDIANA NO. 13.

Bituminous coal from bed No. 6 at Terre Haute, Vigo County, on the Vandalia line, was designated Indiana No. 13. The coal, as worked at a depth of 65 feet at this place, averages 5 feet 3 inches in thickness.

One sample, shipped under the supervision of J. W. Groves, consisted of run-of-mine coal, which was used in steaming tests 432 and 433 and producer-gas tests 132 and 138.

Two mine samples were taken for chemical analysis. Sample 3467 was taken 3,000 feet south of the shaft, where the coal measured 4 feet 10¼ inches in thickness. Sample 3468 was taken 3,000 feet southwest of the shaft, where the coal measured 5 feet 8 inches in thickness.

CHEMICAL ANALYSES.

Indiana No. 13.

	Mine samples.		Car sample.	Steaming tests.[a]	
				432.	433.
Laboratory No	3467	3468	3748	.....	.....
Air-drying loss	8.00	8.30	5.60	.....	.....
Proximate:					
Moisture	13.43	13.88	12.97	12.79	13.58
Volatile matter	36.72	35.89	37.45	35.45	33.93
Fixed carbon	42.51	41.54	39.67	39.67	40.81
Ash	7.34	8.69	12.09	12.09	11.68
Sulphur	2.16	3.26	3.18	3.18	2.92
Ultimate:					
Hydrogen	.....	.....	5.58	4.77	4.80
Carbon	.....	.....	59.84	68.61	69.13
Nitrogen	.....	.....	.82	.94	.95
Oxygen	.....	.....	18.49	8.17	8.22
Ash	.....	.....	.....	13.86	13.52
Sulphur	.....	.....	.....	3.65	3.38
Calorific value determined (as received) calories	6,360	.....	6,055	.....	.....
Calorific value determined (as received) B. t. u.	11,448	.....	10,899	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Indiana No. 13.

		Test 432.	Test 433.
Size as used:			
Over 1 inch	per cent.	46.5	.....
½ inch to 1 inch	do.	21.1	.....
¼ inch to ½ inch	do.	12.7	.....
Under ¼ inch	do.	19.7	.....
Average diameter	inches.	1.33	.....
Duration of test	hours.	10.08	3.75
Heating value of coal	B. t. u. per pound dry coal.	12,497	12,577
Force of draft:			
Under stack damper	inch water.	0.69	0.74
Above fire	do.	.13	.16
Furnace temperature	° F.	2,290	2,260
Dry coal used per square foot of grate surface per hour	pounds.	19.90	20.52
Equivalent water evaporated per square foot of water-heating surface per hour,	pounds.	3.42	3.29
Percentage of rated horsepower of boiler developed		95.8	92.1
Water apparently evaporated per pound of coal as fired	pounds.	6.45	5.97
Water evaporated from and at 212° F.:			
Per pound of coal as fired	do.	7.50	6.93
Per pound of dry coal	do.	8.60	8.02
Per pound of combustible	do.	10.23	9.70
Efficiency of boiler, including grate	per cent.	66.46	61.58
Coal as fired:			
Per indicated horsepower hour	pounds.	3.77	4.08
Per electrical horsepower hour	do.	4.65	5.04
Dry coal:			
Per indicated horsepower hour	do.	3.29	3.53
Per electrical horsepower hour	do.	4.06	4.35

PRODUCER-GAS TESTS.

Indiana No. 13 (run of mine).

		Test 132.	Test 138.
Size as used:			
Over 1 inch	per cent.	36	54
½ inch to 1 inch	do.	24	26
¼ inch to ½ inch	do.	16	12
Under ¼ inch	do.	24	8
Duration of test	hours.	50	24
Average electrical horsepower		160.0	189.8
Average B. t. u. per cubic foot of gas		131.9	178.0
Total coal fired	pounds.	15,300	6,750

	Test 132.			Test 138.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).						
Per electrical horsepower:						
Commercially available	2.02	1.79	1.52	1.55	1.38	1.21
Developed at switchboard	1.91	1.69	1.44	1.48	1.32	1.16
Per brake horsepower:						
Commercially available	1.72	1.52	1.30	1.32	1.18	1.03
Developed at engine	1.63	1.44	1.23	1.26	1.13	0.99
Equivalent used by producer plant (pounds).						
Per electrical horsepower:						
Commercially available	2.21	1.95	1.66	1.68	1.50	1.32
Developed at switchboard	2.09	1.85	1.57	1.61	1.44	1.46
Per brake horsepower:						
Commercially available	1.88	1.66	1.41	1.43	1.27	1.12
Developed at engine	1.77	1.57	1.33	1.39	1.22	1.07

Analyses.

	Test 132.	Test 138.		Test 132.	Test 138.
Coal.			*Gas by volume.*		
Moisture	11.53	10.70	Carbon dioxide (CO_2)	12.5	10.9
Volatile matter	34.80	35.58	Carbon monoxide (CO)	14.9	18.0
Fixed carbon	40.44	42.85	Hydrogen (H_2)	12.8	15.2
Ash	13.23	10.87	Methane (CH_4)	1.9	1.9
Sulphur	3.11	3.06	Nitrogen (N_2)	57.5	53.6
			Oxygen (O_2)	.0	.0
			Ethylene (C_2H_4)	.4	.4

INDIANA NO. 14.

Bituminous coal from bed No. 3 at Seelyville, Vigo County, on the Vandalia line, was designated Indiana No. 14. The coal, as worked at a depth of 90 feet at this place, averages 7 feet 5 inches in thickness.

One sample, consisting of run-of-mine coal, shipped under the supervision of F. B. Tough, was used in steaming tests 430 and 431 and producer-gas test 131.

Two mine samples were taken for chemical analysis. Sample 3491 was taken 2,400 feet northeast of the shaft, where the coal measured 7 feet 5¼ inches in thickness. Sample 3492 was taken 900 feet southeast of the shaft, where the coal measured 7 feet 6¼ inches in thickness.

CHEMICAL ANALYSES.

Indiana No. 14.

	Mine samples.		Car sample.	Steaming tests.[a]	
				430.	431.
Laboratory No	3491	3492	3775	.....	.....
Air-drying loss	8.70	7.00	3.70	.....	.....
Proximate:					
Moisture	13.62	11.46	7.88	8.52	9.39
Volatile matter	38.21	37.45	36.85	35.99	33.58
Fixed carbon	41.06	40.39	41.07	41.10	36.89
Ash	7.11	10.70	14.20	14.39	20.14
Sulphur	3.28	5.45	5.14	5.62	5.47
Ultimate:					
Hydrogen	.....	.....	5.22	4.66	4.28
Carbon	.....	.....	59.75	64.15	58.90
Nitrogen	.....	.....	.93	1.00	.92
Oxygen	.....	.....	14.76	8.32	7.63
Ash	.....	.....	.....	15.73	22.23
Sulphur	.....	.....	.....	6.14	6.04
Calorific value determined (as received) calories	6,413	.....	6,192	.....	.....
Calorific value determined (as received) B. t. u.	11,543	.....	11,146	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Indiana No. 14 (run of mine).

	Test 430.	Test 431.
Size as used:		
Over 1 inch.....per cent..	67.3	36.9
½ inch to 1 inch.....do....	15.4	18.7
¼ inch to ½ inch.....do....	8.0	14.2
Under ¼ inch.....do....	9.3	30.2
Average diameter.....inches..	1.68	1.13
Duration of test.....	9.92	10.00
Heating value of coal.....B. t. u. per pound dry coal..	11,986	11,021
Force of draft:		
Under stack damper.....inch water..	0.69	0.68
Above fire.....do....	.18	.16
Dry coal used per square foot of grate surface per hour.....pounds..	18.89	19.31
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.03	3.02
Percentage of rated horsepower of boiler developed.....	84.9	84.6
Water apparently eveporated per pound of coal as fired.....pounds..	6.30	6.10
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	7.35	7.09
Per pound of dry coal.....do....	8.03	7.83
Per pound of combustible.....do....	9.80	10.42
Efficiency of boiler, including grate.....per cent..	64.70	68.61
Coal as fired:		
Per indicated horsepower hour.....pounds..	3.85	3.99
Per electrical horsepower hour.....do....	4.75	4.92
Dry coal:		
Per indicated horsepower hour.....do....	3.52	3.61
Per electrical horsepower hour.....do....	4.35	4.46

PRODUCER-GAS TEST.

Indiana No. 14 (run of mine).

Test 131.—Size as used, over 1 inch, 50 per cent; ½ inch to 1 inch, 26 per cent; ¼ inch to ½ inch, 12 per cent; under ¼ inch, 12 per cent. Duration of test, 50 hours. Average electrical horsepower, 189.8. Average B. t. u. per cubic foot of gas, 154.1. Total coal fired, 16,200 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.80	1.66	1.40
Developed at switchboard	1.71	1.57	1.33
Per brake horsepower:			
Commercially available	1.53	1.41	1.19
Developed at engine	1.45	1.34	1.13
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.91	1.76	1.49
Developed at switchboard	1.81	1.67	1.41
Per brake horsepower:			
Commercially available	1.62	1.49	1.26
Developed at engine	1.54	1.42	1.20

Analyses.

Coal.		*Gas by volume.*	
Moisture	7.88	Carbon dioxide (CO_2)	9.8
Volatile matter	36.85	Carbon monoxide (CO)	20.4
Fixed carbon	41.07	Hydrogen (H_2)	14.4
Ash	14.20	Methane (CH_4)	2.2
Sulphur	5.14	Nitrogen (N_2)	52.7
		Ethylene (C_2H_4)	.5

INDIANA NO. 15.

Bituminous coal from bed No. 4 at Linton, Greene County, on the Southern Indiana Railroad, was designated Indiana No. 15. The coal, as worked at a depth of 90 feet at this place, averages 4 feet 4 inches in thickness.

One sample, shipped under the supervision of F. B. Tough, consisted of run-of-mine coal, and was used in steaming tests 428 and 429 and producer-gas tests 134 and 137.

Two mine samples were taken for chemical analysis. Sample 3473 was taken 2,000 feet southeast of the shaft, where the coal measured 4 feet 7 inches in thickness. Sample 3474 was taken 1,900 feet northeast of the shaft, where the coal measured 4 feet 1 inch in thickness.

CHEMICAL ANALYSES.

Indiana No. 15.

	Mine samples.		Car sample.	Steaming tests.[a]	
				428.	429.
Laboratory No	3473	3474	3567	.....	.....
Air-drying loss	5.10	7.80	9.10	.....	.....
Proximate:					
Moisture	13.53	13.98	13.58	13.05	12.83
Volatile matter	33.54	32.57	32.07	31.34	32.49
Fixed carbon	45.38	46.35	46.20	46.78	46.45
Ash	7.55	7.10	8.15	8.83	8.23
Sulphur	.95	.96	.91	.99	.97
Ultimate:					
Hydrogen	.....	.....	5.65	4.75	4.78
Carbon	.....	.....	63.53	72.85	73.45
Nitrogen	.....	.....	1.42	1.63	1.64
Oxygen	.....	.....	20.34	9.47	9.58
Ash	.....	.....	.....	10.16	9.44
Sulphur	.....	.....	.....	1.14	1.11
Calorific value determined (as received) calories	6,521	.....	6,344	.....	.....
Calorific value determined (as received) B. t. u.	11,738	.....	11,419	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car samples.

STEAMING TESTS.

Indiana No. 15 (run of mine).

	Test 428.	Test 429.
Size as used:		
Over 1 inch, per cent	44.6	33.9
½ inch to 1 inch, do	21.2	19.5
¼ inch to ½ inch, do	12.1	13.4
Under ¼-inch, do	22.1	33.2
Average diameter, inches	1.03	.85
Duration of test, hours	9.7	10.05
Heating value of coal, B. t. u. per pound dry coal	13,099	13,207
Force of draft:		
Under stack damper, inch water	0.76	0.73
Above fire, do	.14	.13
Dry coal used per square foot of grate surface per hour, pounds	20.12	18.27
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.41	3.13
Percentage of rated horsepower of boiler developed	95.6	87.9
Water apparently evaporated per pound of coal as fired, pounds	6.34	6.43
Water evaporated from and at 212° F.:		
Per pound of coal as fired, do	7.39	7.49
Per pound of dry coal, do	8.50	8.59
Per pound of combustible, do	9.71	9.73
Efficiency of boiler, including grate, per cent	62.66	62.81
Coal as fired:		
Per indicated horsepower hour, pounds	3.83	3.78
Per electrical horsepower hour, do	4.72	4.66
Dry coal:		
Per indicated horsepower hour, do	3.33	3.29
Per electrical horsepower hour, do	4.11	4.06

PRODUCER-GAS TESTS.

Indiana No. 15 (run of mine).

	Test 134.	Test 137.
Size as used:		
Over 1 inch.....per cent..	53	48
½ inch to 1 inch.....do....	19	20
¼ inch to ½ inch.....do....	12	11
Under ¼ inch.....do....	16	21
Duration of test.....hours..	50	50
Average electrical horsepower.....	189.7	193.8
Average B. t. u. per cubic foot of gas.....	144.1	145.7
Total coal fired.....pounds..	14,650	14,050

	Test 134.			Test 137.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).						
Per electrical horsepower:						
Commercially available.....	1.63	1.44	1.30	1.53	1.35	1.22
Developed at switchboard	1.55	1.37	1.24	1.45	1.29	1.16
Per brake horsepower:						
Commercially available.....	1.38	1.23	1.11	1.30	1.15	1.04
Developed at engine.....	1.31	1.16	1.05	1.23	1.09	0.99
Equivalent used by producer plant (pounds).						
Per electrical horsepower:						
Commercially available.....	1.75	1.55	1.39	1.65	1.46	1.32
Developed at switchboard.....	1.66	1.47	1.32	1.56	1.38	1.25
Per brake horsepower:						
Commercially available.....	1.48	1.32	1.16	1.40	1.24	1.12
Developed at engine.....	1.41	1.25	1.12	1.33	1.18	1.06

Analyses.

	Tests 134 and 137.		Test 134.	Test 137.
Coal.		*Gas by volume.*		
Moisture.....	11.42	Carbon dioxide (CO_2)	11.2	10.6
Volatile matter.....	34.11	Carbon monoxide (CO)	17.2	18.3
Fixed carbon.....	45.82	Hydrogen (H_2)	15.2	14.9
Ash.....	8.65	Methane (CH_4)	2.2	2.0
Sulphur.....	1.03	Nitrogen (N_2)	53.8	53.8
		Ethylene (C_2H_4)	.4	.4

INDIANA NO. 16.

Bituminous coal from bed No. 5, at Linton, Greene County, on the Vandalia line, was designated Indiana No. 16. The coal, as worked at a depth of 95 feet at this place, averages 7 feet 2 inches in thickness.

One sample, shipped under the supervision of J. W. Groves, consisted of run-of-mine coal, which was used in steaming tests 426 and 427 and producer-gas test 130.

Two mine samples were taken for chemical analysis. Sample 3475 was taken 650 feet west of the shaft, where the coal measured 7 feet 4 inches in thickness. Sample 3476 was taken 500 feet southeast of the shaft, where the coal measured 7 feet in thickness.

CHEMICAL ANALYSES.

Indiana No. 16.

	Mine samples.		Car sample.	Steaming tests.[a]	
				426.	427.
Laboratory No	3475	3476	3564	.....	.....
Air-drying loss	6.00	8.60	5.90	.....	.....
Proximate:					
Moisture	10.91	11.51	10.30	9.09	10.09
Volatile matter	37.86	36.78	36.31	35.20	33.62
Fixed carbon	42.02	40.49	41.64	43.21	43.51
Ash	9.21	11.22	11.75	12.50	12.78
Sulphur	3.16	4.17	4.23	4.77	4.34
Ultimate:					
Hydrogen	.....	.....	5.38	4.66	4.66
Carbon	.....	.....	61.00	67.02	66.99
Nitrogen	.....	.....	1.06	1.17	1.17
Oxygen	.....	.....	16.58	8.15	8.14
Ash	.....	.....	.....	13.75	14.21
Sulphur	.....	.....	.....	5.25	4.83
Calorific value determined (as received) calories	.....	.....	6,232	.....	.....
Calorific value determined (as received) B. t. u.	.....	.....	11,218	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Indiana No. 16 (run of mine).

	Test 426.	Test 427.
Size as used:		
Over 1 inch, per cent	38.0	27.1
½ inch to 1 inch, do	21.8	25.3
¼ inch to ½ inch, do	14.0	17.0
Under ¼ inch, do	26.2	30.6
Average diameter, inch	0.86	0.76
Duration of test, hours	10.03	9.0
Heating value of coal, B. t. u. per pound dry coal	12,350	12,328
Force of draft:		
Under stack damper, inch water	0.69	0.67
Above fire, do	.13	.15
Dry coal used per square foot of grate surface per hour, pounds	19.26	17.24
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.18	2.80
Percentage of rated horsepower of boiler developed	89.1	78.6
Water apparently evaporated per pound of coal as fired, pounds	6.47	6.30
Water evaporated from and at 212° F.:		
Per pound of coal as fired, do	7.51	7.32
Per pound of dry coal, do	8.26	8.14
Per pound of combustible, do	9.83	9.72
Efficiency of boiler, including grate, per cent	64.59	63.76
Coal as fired:		
Per indicated horsepower hour, pounds	3.77	3.86
Per electrical horsepower hour, do	4.65	4.77
Dry coal:		
Per indicated horsepower hour, do	3.42	3.47
Per electrical horsepower hour, do	4.23	4.29

PRODUCER-GAS TEST.

Indiana No. 16 (run of mine).

Test 130.—Duration of test, 50 hours. Average electrical horsepower, 177.4. Average B. t. u. per cubic foot of gas, 136.7. Total coal fired, 16,100 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.92	1.77	1.54
Developed at switchboard	1.82	1.68	1.46
Per brake horsepower:			
Commercially available	1.63	1.51	1.31
Developed at engine	1.54	1.42	1.24

PRODUCER-GAS TEST—Continued.

Indiana No. 16 (run of mine).

	Coal as fired.	Dry coal.	Combustible.
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.06	1.90	1.66
Developed at switchboard	1.95	1.80	1.57
Per brake horsepower:			
Commercially available	1.75	1.62	1.41
Developed at engine	1.66	1.53	1.33

Analyses.

Coal.		*Gas by volume.*	
Moisture	7.79	Carbon dioxide (CO_2)	11.4
Volatile matter	32.32	Carbon monoxide (CO)	16.8
Fixed carbon	44.97	Hydrogen (H_2)	13.3
Ash	11.92	Methane (CH_4)	1.7
Sulphur	4.01	Nitrogen (N_2)	56.3
		Ethylene (C_2H_4)	.5

INDIANA NO. 17.

Bituminous coal from bed No. 5 at Bicknell, Knox County, on the Vandalia line, was designated Indiana No. 17. The coal, as worked at a depth of 190 feet at this place, averages 5 feet 6 inches in thickness.

One sample, shipped under the supervision of J. W. Groves, consisted of run-of-mine coal and was used in steaming tests 441 and 442, coking test 163, and cupola test 148.

Two mine samples were taken for chemical analysis. Sample 3516 was taken 500 feet northeast of the shaft, where the coal measured 5 feet 2 inches in thickness. Sample 3517 was taken 250 feet northwest of the shaft, where the coal measured 5 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Indiana No. 17.

	Mine samples.		Car. sample.	Steaming tests.[a]	
				441.	442.
Laboratory No	3516	3517	3981	.....	.....
Air-drying loss	6.10	6.90	5.10	.....	.....
Proximate:					
Moisture	10.60	11.87	12.08	9.70	12.08
Volatile matter	38.06	36.23	32.48	35.78	32.48
Fixed carbon	43.04	43.84	44.42	45.63	44.42
Ash	8.30	8.06	11.02	8.89	11.02
Sulphur	3.69	4.05	3.65	3.67	3.65
Ultimate:					
Hydrogen	.....	.....	5.34	4.70	4.55
Carbon	.....	.....	60.45	71.05	68.75
Nitrogen	.....	.....	.89	1.04	1.01
Oxygen	.....	.....	18.65	9.30	9.00
Ash	.....	.....	.....	9.85	12.54
Sulphur	.....	.....	.....	4.06	4.15
Calorific value determined (as received) calories	6,529	.....	6,117	.....	.....
Calorific value determined (as received) B. t. u.	11,752	.....	11,011	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Indiana No. 17 (run of mine).

	Test 441.	Test 442.
Size as used:		
Over 1 inch....per cent..	47.3	16.8
½ inch to 1 inch....do....	26.9	22.7
¼ inch to ½ inch....do....	13.6	18.0
Under ¼ inch....do....	12.2	42.5
Average diameter....inches..	1.20	0.60
Duration of test....hours..	9.88	10.13
Heating value of coal....B. t. u. per pound dry coal..	12,929	12,524
Force of draft:		
Under stack damper....inch water..	0.75	0.74
Above fire....do....	.13	.15
Furnace temperature....°F..	2,545	2,544
Dry coal used per square foot of grate surface per hour....pounds..	19.61	17.98
Equivalent water evaporated per square foot of water-heating surface per hour, pounds....	3.23	2.79
Percentage of rated horsepower of boiler developed....	90.7	78.2
Water apparently evaporated per pound of coal as fired....pounds..	6.41	5.85
Water evaporated from and at 212°F.:		
Per pound of coal as fired....pounds..	7.46	6.83
Per pound of dry coal....do....	8.26	7.77
Per pound of combustible....do....	9.53	9.35
Efficiency of boiler, including grate....per cent..	61.70	59.91
Coal as fired:		
Per indicated horsepower hour....pounds..	3.70	4.14
Per electrical horsepower hour....do....	4.68	5.11
Dry coal:		
Per indicated horsepower hour....do....	3.42	3.64
Per electrical horsepower hour....do....	4.23	4.49

COKING TEST.

Indiana No. 17 (run of mine).

Test 163.—Size as used, washed, finely crushed. Duration of test, 50 hours. Coal charged, 12,050 pounds. Coke produced, 7,200 pounds; 59.75 per cent. Breeze produced, 332 pounds; 2.76 per cent. Total yield, 62.51 per cent. Dark-gray color; poor, dense coke; ash and sulphur high.

Analyses.

	Coal.	Coke.
Moisture	10.57	1.65
Volatile matter	35.65	.67
Fixed carbon	43.77	81.42
Ash	10.01	16.26
Sulphur	3.76	3.39

Cupola test of coke made from Indiana No. 17 coal (washed).

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
148	163	1.92	7	94.44	Coke	190	60	60	60	60	430
					Pig iron	760	560	560	560	560	3,000

Cupola test of coke made from Indiana No. 17 coal (washed)—Continued.

RECORD OF MELT.

Cupola test No.	Blast pressure.		Iron running in—	Weight of iron.			Melting.				Recovered.	
	On at—	Maximum.		Poured.	Additional melted.	Total.	Time.	Rate per hour.	Ratio iron to coke.	Loss.	Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
148	11.17 a. m...	7	11	1,548	274	1,822	32	3,416	4.82	4.50	1,043	52

SILICON, MANGANESE, ETC.

Cupola test No.	Materials.	Amount used (pounds).	Silicon.		Manganese.		Sulphur.		
			Per cent.	Pounds.	Per cent.	Pounds.	Per cent.	Pounds.	Content of coke combined with iron melted (per cent).
148	Pig iron		2.12	38.63	0.178	3.243	0.059	1.0750	6.88
	Melted iron:								
	Amount		1.75	31.88	.126	2.296	.108	1.9678	
	Gain or loss		—17.47	—6.75	—29.20	—.947	+.049	+.8928	
	Coke	383					3.39	12.9837	

LADLE RECORD.

Ladle No.	Pounds.	Time (a.m.).	Ladle No.	Pounds.	Time (a.m.).
1	24	11.30	11	96	11.47
2	95	11.34	12	80	11.49
3	101	11.34½	13	73	11.49½
4	79	11.39	14	96	11.50
5	94	11.39½	15	65	11.54
6	108	11.40	16	68	11.54½
7	76	11.41	17	85	11.55
8	98	11.42	18	56	11.59
9	78	11.46	19	108	12.00
10	68	11.46½			

Remarks.—Pig iron used from car 27633. Temperature of iron, medium.

INDIANA NO. 18.

Bituminous coal from bed No. 5 at Ayrshire, Pike County, on the Southern Railway, was designated Indiana No. 18. The coal, as worked from the outcrop at this place, averages 4 feet 9 inches in thickness.

Two samples were shipped under the supervision of John W. Groves, as follows: Indiana No. 18 A consisted of washed slack screened through a $\frac{7}{8}$-inch wire-mesh revolving screen, and was used in coking tests 158 and 168. Indiana No. 18 B consisted of lump coal over a $1\frac{3}{4}$-inch round shaking screen, and was used in steaming tests 435 and 436 and producer-gas tests 133 and 135.

Two mine samples were taken for chemical analysis. Sample 3525 was taken 3,400 feet south of the opening, where the coal

measured 4 feet 9 inches in thickness. Sample 3526 was taken 3,400 feet southwest of the opening, where the coal measured 4 feet 10 inches in thickness.

CHEMICAL ANALYSES.

Indiana No. 18.

	Mine samples.		Car sample (B).	Steaming tests.[a]	
				435.	436.
Laboratory No	3525	3526	3801	.....	.....
Air-drying loss	5.30	7.40	3.10	.....	.....
Proximate:					
Moisture	12.88	13.83	11.13	12.04	12.09
Volatile matter	34.71	34.24	35.11	34.09	34.10
Fixed carbon	46.27	45.91	46.78	46.84	47.03
Ash	6.14	6.02	6.98	7.03	6.78
Sulphur	1.70	1.41	1.64	1.65	1.37
Ultimate:					
Hydrogen	.....	.....	5.65	4.92	4.96
Carbon	.....	.....	66.94	74.22	74.72
Nitrogen	.....	.....	1.34	1.30	1.30
Oxygen	.....	.....	17.45	9.69	9.75
Ash	.....	.....	.....	7.99	7.71
Sulphur	.....	.....	.....	1.88	1.56
Calorific value determined (as received)..calories	6,556	.....	6,684	.....	.....
Calorific value determined (as received)..B. t. u.	11,801	.....	12,031	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Indiana No. 18 B (lump).

	Test 435.	Test 436.
Size as used:		
Over 1 inch.....per cent	30.4	45.1
½ inch to 1 inch.....do	17.4	23.5
¼ inch to ½ inch.....do	21.8	12.8
Under ¼ inch.....do	30.4	18.6
Average diameter inch	0.77	0.97
Duration of test.....hours	10.1	9.67
Heating value of coal.....B. t. u. per pound dry coal	13,545	13,617
Force of draft:		
Under stack damper.....inch water	0.64	0.73
Above fire.....do	.05	.07
Dry coal used per square foot of grate surface per hour.....pounds	20.47	21.85
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.62	3.91
Percentage of rated horsepower of boiler developed	101.4	109.7
Water apparently evaporated per pound of coal as fired.....pounds	6.70	6.76
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do	7.79	7.89
Per pound of dry coal.....do	8.85	8.97
Per pound of combustible.....do	9.86	10.05
Efficiency of boiler, including grate.....per cent	63.10	63.61
Coal as fired:		
Per indicated horsepower hour.....pounds	3.63	3.58
Per electrical horsepower hour.....do	4.48	4.42
Dry coal:		
Per indicated horsepower hour.....do	3.20	3.15
Per electrical horsepower hour.....do	3.94	3.89

PRODUCER-GAS TESTS.

Indiana No. 18 B (lump).

	Test 135.	Test 133.
Size as used:		
Over 1 inch ..... per cent..	65	62
½ inch to 1 inch ..... do....	15	17
¼ inch to ½ inch ..... do....	8	9
Under ¼ inch ..... do....	12	12
Duration of test ..... hours..	50	36
Average electrical horsepower	196.3	194.5
Average B. t. u. per cubic foot of gas	152.6	154.7
Total coal fired ..... pounds..	16,350	10,350

	Test 135.			Test 133.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).						
Per electrical horsepower:						
Commercially available	1.75	1.54	1.42	1.55	1.38	1.27
Developed at switchboard	1.67	1.46	1.35	1.48	1.31	1.21
Per brake horsepower:						
Commercially available	1.49	1.31	1.21	1.32	1.17	1.08
Developed at engine	1.42	1.24	1.15	1.26	1.12	1.03
Equivalent used by producer plant (pounds).						
Per electrical horsepower:						
Commercially available	1.88	1.65	1.52	1.67	1.48	1.37
Developed at switchboard	1.79	1.57	1.45	1.59	1.41	1.30
Per brake horsepower:						
Commercially available	1.60	1.40	1.29	1.42	1.26	1.16
Developed at engine	1.52	1.34	1.23	1.35	1.20	1.11

Analyses.

	Test 135.	Test 133.		Test 135.	Test 133.
Coal.			*Gas by volume.*		
Moisture	12.11	11.13	Carbon dioxide (CO_2)	10.8	10.0
Volatile matter	34.19	35.11	Carbon monoxide (CO)	18.6	19.4
Fixed carbon	46.87	46.78	Hydrogen (H_2)	16.9	16.0
Ash	6.83	6.98	Methane (CH_4)	2.1	2.1
Sulphur	1.44	1.64	Nitrogen (N_2)	51.3	52.2
			Ethylene (C_2H_4)	.....	.3

COKING TESTS.

Indiana No. 18 A (washed slack).

	Test 158.	Test 168.
Size as used	not cr.	f. c.
Duration of test ..... hours..	16	24
Coal charged ..... pounds..	11,800	12,740
Coke produced	None.	None.

Remarks.—Test 158: Charge ashed down about 2 inches and blaze lost. Test 168: Charge ashed down about 3 inches and blaze lost.

Coking analyses of coal.

	Test 158.	Test 168.
Moisture	15.09	13.97
Volatile matter	31.06	30.97
Fixed carbon	46.42	48.07
Ash	7.43	6.99
Sulphur	1.48	1.49

INDIANA NO. 19.

Bituminous coal from the "Brazil Block top bed," at Diamond, Parke County, on the Chicago and Eastern Illinois Railroad, was designated Indiana No. 19. The coal, as worked at a depth of 121 feet at this place, averages 4 feet 4 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of screenings (through 1¼-inch stationary bar screen), and was used in steaming test 464 (on briquets) and briquetting test 165*.

Two mine samples were taken for chemical analysis. Sample 3534 was taken 1,200 feet southwest of the shaft, where the coal measured 4 feet 9 inches in thickness. Sample 3535 was taken 500 feet east of the shaft, where the coal measured 4 feet 1 inch in thickness.

CHEMICAL ANALYSES.

Indiana No. 19.

	Mine samples.		Steaming test 464.[a]	Briquetting test 165*.[b]
Laboratory No.	3534	3535	.....	4315
Air-drying loss	6.70	8.90	.....	.....
Air-dried sample:				
Proximate—				
Moisture	13.70	13.93	9.09	4.89
Volatile matter	35.94	35.18	34.61	30.53
Fixed carbon	44.45	45.82	40.70	44.00
Ash	5.91	5.07	15.60	20.58
Sulphur	2.66	1.93	3.04	3.36
Ultimate—				
Hydrogen	.....	.....	4.34	4.18
Carbon	.....	.....	63.67	61.71
Nitrogen	.....	.....	1.13	1.00
Oxygen	.....	.....	10.36	7.94
Ash	.....	.....	17.16	21.64
Sulphur	.....	.....	3.34	3.53
Calorific value determined (as received) calories	6,628	.....	.....	.....
Calorific value determined (as received) B. t. u.	11,930	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TEST.

Indiana No. 19 (Renfrow briquets).

	Test 464.
Duration of test.....hours..	7.57
Heating value of fuel.....B. t. u. per pound dry fuel..	11,930
Force of draft:	
Under stack damper.....inch water..	0.79
Above fire.....do....	.16
Furnace temperature.....°F..	2,613
Dry fuel used per square foot of grate surface per hour.....pounds..	20.86
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	3.28
Percentage of rated horsepower of boiler developed.....	91.8
Water apparently evaporated per pound of fuel as fired.....pounds..	5.92
Water evaporated from and at 212° F.:	
Per pound of fuel as fired.....do....	7.15
Per pound of dry fuel.....do....	7.86
Per pound of combustible.....do....	9.62
Efficiency of boiler, including grate.....per cent..	63.62
Fuel as fired:	
Per indicated horsepower hour.....pounds..	3.96
Per electrical horsepower hour.....do....	4.88
Dry fuel:	
Per indicated horsepower hour.....do....	3.60
Per electrical horsepower hour.....do....	4.44

Remarks.—Test made on briquets from test 165*, which burned well with short flame, making 5.5 per cent of black smoke. Briquets broke enough in burning to allow small percentage of fine unconsumed fuel to pass through grate. Ash and clinker of dark-gray color, not sufficient to retard draft. Clinker was easily broken with hook, but stuck to burning fuel; 33 per cent clinker was formed.

BRIQUETTING TEST.

Indiana No. 19 (raw screenings).

*Test 165**.—Size as used: Over $\frac{1}{4}$ inch, 3.6 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 12.4 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 20 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 24 per cent; through $\frac{1}{40}$ inch, 40 per cent. When made with dry coal and 8 per cent binder briquets were hard, with firm surfaces and very rough fracture. With moist coal satisfactory briquets were made regardless of percentage of binder used. These briquets had a dull-gray color, due to the presence of a large amount of clay. For analyses of briquets see page 143.

Details of manufacture:		Drop test (1-inch screen):	
Machine used	Renf.	Held.....per cent..	64.0
Temperature of briquets.....°F..	131	Passed.....do....	36.0
Binder—		Tumbler test (1-inch screen):	
Kind	w. g. p.	Held.....do....	89.0
Laboratory No. (see p. 40)	[a] 3962, 4120	Passed (fines).....do....	11.0
Amount.....per cent..	8	Fines through 10-mesh sieve.do....	91.5
Weight of—		Weathering test:	
Fuel briquetted.....pounds..	80,000	Time exposed.....days..	95
Briquets, average.....do....	0.562	Condition	C.
Heat value per pound—		Water absorption:	
Fuel as received.....B. t. u..	9,524	In 16 days.....per cent..	12.6
Fuel as fired.....do....	10,710	Average for first 5 days.....do....	1.90
Binder.....do....	16,946	Specific gravity (apparent)	1.211

[a] Binder contained 6 parts No. 4120 and 1 part No. 3962.

Extraction analyses.

	Pitches.		Fuel.	Briquets test 165*.
Laboratory No	3962	4120	3979	4315
Air-drying loss, per cent			13.10	5.40
Extracted by CS_2:				
Air-dried, do			.97	7.81
As received, do	77.79	97.70	1.12	7.39
Pitch in briquets, as received, do				6.90

INDIANA NO. 20.

Bituminous coal from the "Brazil Block bottom bed," at Brazil, Clay County, on the Chicago and Eastern Illinois Railroad, was designated Indiana No. 20. This coal, as worked at a depth of 148 feet at this place, averages 3 feet 7 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of screenings through a 1¼-inch bar screen, and was used in washing test 185 and briquetting test 169*.

Two mine samples were taken for chemical analysis. Sample 3536 was taken 800 feet southeast of the shaft, where the coal measured 3 feet 5 inches in thickness. Sample 3537 was taken 600 feet northwest of the shaft, where the coal measured 3 feet 8 inches in thickness.

CHEMICAL ANALYSES.

Indiana No. 20.

	Mine samples.		Car sample.	Briquetting test 169*.[a]
Laboratory No	3536	3537	3979	4627
Air-drying loss	11.30	10.40	13.10	.....
Proximate:				
Moisture	15.38	15.91	16.91	9.67
Volatile matter	32.66	33.19	26.85	35.75
Fixed carbon	46.08	46.05	38.87	47.65
Ash	5.88	4.85	17.37	6.93
Sulphur	1.95	1.22	1.89	1.40
Ultimate:				
Hydrogen	.....	.....	5.48	5.06
Carbon	.....	.....	52.97	75.14
Nitrogen	.....	.....	1.01	1.25
Oxygen	.....	.....	21.28	9.33
Ash	.....	.....	.....	7.67
Sulphur	.....	.....	.....	1.55
Calorific value determined (as received), calories	6,489	.....	5,291	.....
Calorific value determined (as received), B. t. u.	11,680	.....	9,524	.....

[a] Proximate analysis of fuel as received; ultimate analysis on dry basis.

WASHING TEST.

Indiana No. 20 (screenings).

Test 185.—Size as used, screenings. Jig used, Stewart. Raw coal, 60,000 pounds. Washed coal, 40,000 pounds; 67 per cent. Refuse, 20,000 pounds; 33 per cent. For analysis of raw coal used see above (car sample 3979). Washed-coal analysis: Moisture, 16.86; ash, 7.09; sulphur, 1.35.

BRIQUETTING TEST.

Indiana No. 20 (washed screenings).

*Test 169**.—Size as used: $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 3.0 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 16.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 26.6 per cent; through $\frac{1}{40}$ inch, 54.2 per cent. Briquets satisfactory when made warm, using 7 per cent binder; surface became soft and easily abraded as briquets cooled; were easily handled from machine, but produced high percentage of slack in handling afterwards. Fracture was rough and color brighter than in briquets from unwashed fuel. For analyses of briquets see page 145.

Details of manufacture:		Drop test (1-inch screen):	
Machine used	Renf.	Held.....per cent..	39.0
Temperature of briquets.....°F..	131	Passed.....do....	61.0
Binder—		Tumbler test (1-inch screen):	
Kind	w. g. p.	Held.....do....	71.0
Laboratory No. (see p. 40)	4318 / 4543	Passed (fines).....do....	29.0
Amount.....per cent..	7	Fines through 10-mesh sieve..do....	93.8
Weight of—		Weathering test:	
Fuel briquetted.....pounds..	30,000	Time exposed.....days..	48
Briquets, average.....do....	0.427	Condition	B.
Heat value per pound—		Water absorption:	
Fuel as received.....B. t. u..	12,994	In 19 days.....per cent..	28.5
Fuel as fired.....do....	12,391	Average for first 4 days.....do....	4.0
Binder.....do....	16,811	Specific gravity (apparent)	0.903

Extraction analyses.

	Pitches.		Fuel.	Briquets, test 169*.
Laboratory No.	4318	4543	3979	4627
Air-drying loss.....per cent..			13.10	7.90
Extracted by CS_2:				
Air-dried.....do....			.73	9.12
As received.....do....	90.42	99.66	.63	8.40
Pitch in briquets, as received.....do....				8.39

INDIAN TERRITORY.

INDIAN TERRITORY NO. 2.[a]

Bituminous coal from the Hartshorne bed, at Hartshorne, on the Rock Island Railroad, was designated "Indian Territory No. 2." The coal, as worked from the outcrop and by shafts at this place, averages 4 feet 1 inch in thickness.

Two samples of coal were shipped, as follows: Indian Territory No. 2 B, uninspected, consisted of slack screenings (through a $\frac{5}{8}$-inch shaking screen) and was used in steaming tests 418, 453 (on briquets), and 456 (on briquets); washing test 176; and briquetting tests 135, 136, 137, 138, 139, 145, 146, 147, 148*†, 149*, 157†, and 168. Indian Territory No. 2 C, shipped under the supervision of John W. Groves, consisted of lump coal over a 1-inch shaking screen, and was used in steaming test 455 and briquetting tests 153, 154, 155, and 156. Indian Territory Nos. 2 B and 2 C were used (mixed) in steaming test 417.

[a] For other tests of coal from this mine, made during 1904, see Bull. U. S. Geol. Survey No. 261, 1905, pp. 39, 67, 81, 124, 155; and Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 69, 215, 505, 1337, 1439, 1467.

CHEMICAL ANALYSES.

Indian Territory No. 2.

	Steaming tests.[a]					Briquetting tests.[b]				
	B.			417 (B and C).	455 (C).	B.				
	418.	453.	456.			135, 136.	137, 168.	145, 146, 147.	139.	149*.
Proximate:										
Moisture	2.92	3.29	2.85	2.88	2.70	3.61	3.85	2.87	2.80	2.13
Volatile matter	36.14	35.25	34.91	35.40	35.84	33.03	34.06	35.02	35.67	36.97
Fixed carbon	52.42	53.15	54.03	51.87	53.40	49.64	49.36	50.60	53.77	54.14
Ash	8.52	8.31	8.21	9.85	8.06	13.72	12.73	11.51	7.76	6.76
Sulphur	1.98	1.52	1.50	1.80	1.46	1.76	1.71	1.72	1.58	1.47
Ultimate:										
Hydrogen	4.94	4.93	4.87	4.89	4.95	4.65	4.54	4.48	4.91	5.04
Carbon	75.63	76.11	76.28	74.63	76.57	71.08	73.17	73.39	75.63	77.98
Nitrogen	1.91	1.69	1.71	1.88	1.79	1.46	1.61	1.49	1.52	1.78
Oxygen	6.70	7.11	7.15	6.61	6.91	6.75	5.66	7.02	8.33	6.79
Ash	8.78	8.59	8.45	10.14	8.28	14.23	13.24	11.85	7.98	6.91
Sulphur	2.04	1.57	1.54	1.85	1.50	1.83	1.78	1.77	1.63	1.50

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Indian Territory No. 2.

	B (slack).			B and C.	C (lump).
	Test 418.	Test 453.	Test 456 (w.)	Test 417.	Test 455.
Size as used:					
Over 1 inch.....per cent	25.5	See "Remarks" (below).	See "Remarks" (below).	25.2	(a)
½ inch to 1 inch.....do	31.4			27.6	
¼ inch to ½ inch.....do	18.6			18.7	
Under ¼ inch.....do	24.5			28.5	
Average diameter.....inch	0.78			0.75	
Duration of test.....hours	10.05	10.05	10.08	10.15	9.92
Heating value of fuel..B. t. u. per pound of dry fuel	13,721	13,687	13,856	13,534	13,957
Force of draft:					
Under stack damper.....inch water	0.63	0.78	0.87	0.58	0.64
Above fire.....do	.11	.17	.14	.09	.17
Furnace temperature.....°F	.....	2,653	2,704	.....	2,807
Dry fuel used per square foot of grate surface per hour.....pounds	18.10	19.93	21.38	17.81	19.90
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds	3.39	3.75	3.80	3.23	3.34
Percentage of rated horsepower of boiler developed	95.0	105.1	106.6	90.5	93.5
Water apparently evaporated per pound of fuel as fired.....pounds	7.81	7.60	7.23	7.57	6.82
Water evaporated from and at 212° F.:					
Per pound of fuel as fired.....do	9.10	9.12	8.65	8.83	8.17
Per pound of dry fuel.....do	9.38	9.42	8.90	9.09	8.39
Per pound of combustible.....do	10.65	10.80	10.00	10.62	9.52
Efficiency of boiler, including grate.....per cent	66.02	66.46	62.03	64.86	58.05
Fuel as fired:					
Per indicated horsepower hour.....pounds	3.11	3.10	3.27	3.20	3.46
Per electrical horsepower hour.....do	3.84	3.83	4.04	3.95	4.27
Dry fuel:					
Per indicated horsepower hour.....do	3.01	3.00	3.18	3.11	3.37
Per electrical horsepower hour.....do	3.72	3.71	3.92	3.84	4.16

[a] See page 148.

Remarks.—Test 453 on briquets from test 148*†: Briquets were badly broken up from weathering and handling. Fuel burned quickly, with medium flame, intense heat, and 4.5 per cent black smoke. Considerable of the slack from the briquets fell through the grates. Clinker was thin, dark gray in color, not porous, and stuck to the grate.

Test 456 on briquets from tests 138 and 157†: Briquets from test 138 burned readily, with short, yellow flame, intense heat, and 7 per cent black smoke. Briquets from test 157† burned well until clinker formed over the grate. Best results were obtained when briquets were fired whole; 8.5 per cent black smoke. Clinker on both tests was

very heavy and of a dark-purple color, and formed in layers. Water thrown into ash pit did not prevent clinker from sticking to grate.

Test 455 on briquets from tests 153, 154, 155, and 156 (equal parts): Square briquets did not give as good results as round ones, owing to holes in the fire, although they made less clinker on account of cooler fire; 8 per cent black smoke. Clinker was tough, purple in color; formed a thin layer over and stuck to the grate.

WASHING TEST

Indian Territory No. 2 B.

Test 176.—Size as shipped, slack. Size as used, slack. Jig used, modified Stewart. Raw coal, 38,000 pounds. Washed coal, 29,060 pounds; 78 per cent. Refuse, 8,940 pounds; 22 per cent.

Analyses.

	Raw coal.	Washed coal.
Moisture	6.27	6.61
Volatile matter	32.37	.....
Fixed carbon	47.07	.....
Ash	14.29	8.27
Sulphur	1.79	1.55

BRIQUETTING TESTS.

Indian Territory No. 2.

Tests 135, 136, 137, 145, 146, 147, 148†, and 168 (coal B, raw slack).*—There was no apparent difference in English briquets with 6, 7, and 8 per cent binder. A small lot with 5 per cent binder showed shortage of pitch. Pressure on machine was changed during making of Renfrow briquets, as indicated in tests. All briquets were satisfactory, having sharp edges, hard surfaces, and clean, rough fracture; could be handled from machine while warm and piled 5 feet high without sticking together or crushing. For analyses of briquets see page 147 (briquets from test 148*† under "Steaming test 453").

	Test 135.	Test 136.	Test 137.	Test 145.	Test 146.	Test 147.	Test 148*†.	Test 168.
Details of manufacture:								
Machine used	Eng.	Eng.	Eng.	Eng.	Eng.	Eng.	Renf.	Renf.
Temperature of briquets ...°F.	185	185	185	185	185	185	149	149
Binder—								
Kind	w.g.p.	w.g.p.	w.g.p.	w.g.p.	w.g.p.	w.g.p.	w.g.p.	w.g.p.
Laboratory No. (see p. 40)	3258	3258	3296	3486	3623	3624	3486	3296
Amount.....per cent.	6	7	8	6	7	8	8	8
Weight of—								
Fuel briquetted....pounds.	11,000	22,000	70,000	16,000	16,000	16,000	19,400	99,000
Briquets, average.....do....	3.46	3.88	3.77	3.53	3.64	3.43	0.515	0.508
Heat value per pound—								
Fuel as received.....B. t. u.	12,400	12,400	12,400	12,033	12,033	12,033	12,033	12,400
Fuel as fired.....do....	12,317	12,317	12,481	12,811	12,811	12,811	13,412	12,481
Binder.....do....	16,373	16,373	16,427	16,241	16,241	16,241	16,407	16,427
Drop test (1-inch screen):								
Held.....per cent.	.....	.....	.....	81.7	82.8	84.2	58.5	.....
Passed.....do....	.....	.....	.....	18.3	17.2	15.8	41.5	.....
Tumbler test (1-inch screen):								
Held.....do....	.....	74.8	.....	73.3	79.8	80.8	81.0	.....
Passed.....do....	.....	25.2	.....	26.7	20.2	19.2	19.0	.....
Fines through 10-mesh sieve, per cent.....	.....	75.0	.....	86.5	85.6	75.5	95.4	.....
Weathering test:								
Time exposed.....days.	239	239	239	145	145	145	144	239
Condition.....	B.	C.	B.	B.	A.	A.	B.	B.
Water absorption:								
In 16 days.....per cent.	.....	.....	.....	8.6	10.2	11.4	12.9	.....
Average for first—								
13 days.....do....	.....	.....	.....	1.62	.72	.84	.....	.....
6 days.....do....	.....	.....	.....	.....	.....	.....	1.7	.....
Specific gravity (apparent)	.....	.....	.....	1.151	1.133	1.076	1.117	.....

Extraction analyses.[a]

	Fuel.		Briquets.				
			Tests 135, 136.	Test 137.	Tests 145, 146, 147.	Test 148*†.	Test 168.
Laboratory No.	3381	3472	3262	3342	3520	4086	3343
Air-drying loss.....per cent..	1.50	3.80	1.50	.....	1.00	1.30	.....
Extracted by CS_2:							
Air-dried.....do....	.33	.43	4.80	.....	8.87	6.11	.....
As received.....do....	.32	.41	4.72	6.32	8.78	6.00	8.84
Pitch in briquets as received, per cent.....	.....	.....	5.50	7.32	10.19	6.57	10.40

[a] The extraction analyses of the pitches used can be found by referring to page 40.

Tests 138, 139, 149, and 157† (coal B, washed slack); tests 153, 154, 155, and 156 (coal C, lump).*—Tests 138 and 139 were made from the first sample sent to the plant, and tests 149* and 157† from the second sample. Excellent briquets were made with 8 per cent binder. The English briquets showed the advantage of higher pressure by being harder and closer grained and having smoother surfaces and sharper edges. Similar differences mark the superiority of these briquets over those from the same slack unwashed.

The briquets made from lump coal (C) may be considered as standing in value between those made from washed and those made from unwashed slack from the same mine; they are identical in appearance.

For analyses of briquets see page 147 (briquets from tests 138 and 157† under "Steaming test 456," from tests 153, 154, 155, and 156 under "Steaming test 455").

	B.				C.			
	Test 138.	Test 139.	Test 149*.	Test 157†.	Test 153.	Test 154.	Test 155.	Test 156.
Details of manufacture:								
Machine used	Eng.	Renf.	Renf.	Eng.	Eng.	Eng.	Eng.	Renf.
Temperature of briquets...° F..	185	149	149	185	185	185	185	14
Binder—								
Kind	w.g.p.	w.g.p.	w.g.p.	w.g.p.	w.g.p.	w.g.p.	w.g.p.	w.g.p.
Laboratory No. (see p. 40)..	3624	3296	3624	3624	3486	3486	3486	3486
Amount.....per cent..	8	8	8	8	6	7	8	8
Weight of—								
Fuel briquetted....pounds..	16,000	20,000	40,000	8,000	1,000	1,000	1,000	8,000
Briquets, average.....do....	3.31	0.451	0.476	3.34	3.11	3.19	3.14	0.490
Heat value per pound—								
Fuel as received....B. t. u..	.....	.....	.....	.....	13,630	13,630	13,630	13,630
Fuel as fired.....do....	13,562	13,541	13,707	13,707	13,581	13,581	13,581	13,581
Binder.....do....	16,427	16,427	16,193	16,193	16,407	16,407	16,407	16,407
Drop test (1-inch screen):								
Held.....per cent..	88.9	60.0	56.0	85.5	79.8	84.6	86.4	70.0
Passed.....do....	11.1	40.0	44.0	14.5	20.2	15.4	13.6	30.0
Tumbler test (1-inch screen):								
Held.....do....	85.0	79.0	76.0	82.5	71.0	76.6	83.5	81.5
Passed (fines).....do....	15.0	21.0	24.0	17.5	29.0	23.4	16.5	18.5
Fines through 10-mesh sieve, per cent.....	79.5	90.5	93.7	78.1	82.3	80.6	78.4	90.9
Weathering test:								
Time exposed.....days..	128	127	149	128	239	239	239	182
Condition.....	B.	C.	B.	A.	C.	C.	C.	B.
Water absorption:								
In 19 days.....per cent..	9.6	14.7	16.0	10.3	12.6	11.1	.....	13.5
In 15 days.....do....	.....	.....	.....	.....	.....	.....	10.2	.....
Average for first—								
5 days.....do....	1.20	2.0	2.26	1.06	.....	1.34	1.57	1.84
12 days.....do....	.....	.....	.....	.....	0.93	.....	.....	.....
Specific gravity (apparent).....	1.097	1.061	1.024	1.096	1.070	1.084	1.088	1.077

Extraction analyses.[a]

	B.					C.	
	Fuel.		Briquets.			Fuel.	Briquets, tests 153, 154, 155, 156.
			Test 139.	Test 149*.	Tests 138, 157†.		
Laboratory No.	3281	3487	3896	3559	4108	3657	4099
Air-drying loss.....per cent.	.....	4.60	1.20	0.5	0.90	.....	0.80
Extracted by CS_2:							
Air-dried.....do....	0.43	1.06	7.67	6.43	6.10	.....	5.75
As received.....do....	.41	1.01	7.58	6.40	6.04	1.00	5.70
Pitch in briquets, as received, per cent.	.....	.....	8.75	6.22	6.32	.....	5.56

[a] The extraction analysis of the pitches used can be found by referring to p. 40.

INDIAN TERRITORY NO. 8.

Bituminous coal sent in uninspected, designated Indian Territory No. 8, was used in steaming test 437 and washing test 175.

CHEMICAL ANALYSES.

Indian Territory No. 8.

	Steaming test 437.[a]		Steaming test 437.[a]
Proximate:		Ultimate:	
Moisture	2.80	Hydrogen	4.91
Volatile matter	35.67	Carbon	75.63
Fixed carbon	53.77	Nitrogen	1.52
Ash	7.76	Oxygen	8.33
Sulphur	1.58	Ash	7.98
		Sulphur	1.63

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Indian Territory No. 8 (washed, Renfrow briquets).

	Test 437.
Duration of test.....hours..	7.45
Heating value of coal.....B. t. u. per pound dry coal..	13,932
Force of draft:	
Under stack damper.....inch water..	0.70
Above fire.....do....	.05
Dry coal used per square foot of grate surface per hour.....pounds..	19.31
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	3.43
Percentage of rated horsepower of boiler developed	96.0
Water apparently evaporated per ponud of coal as fired.....pounds..	7.45
Water evaporated from and at 212° F.:	
Per pound of coal as fired.....do....	8.64
Per pound of dry coal.....do....	8.89
Per pound of combustible.....do....	10.08
Efficiency of boiler, including grate.....per cent..	61.62
Coal as fired:	
Per indicated horsepower hour.....pounds..	3.27
Per electrical horsepower hour.....do....	4.04
Dry coal:	
Per indicated horsepower hour.....do....	3.18
Per electrical horsepower hour.....do....	3.93

WASHING TEST.

Indian Territory No. 8.

Test 175.—Jig used, Stewart. Raw coal, 37,600 pounds. Washed coal, 32,300 pounds; 86 per cent. Refuse, 5,300 pounds; 14 per cent.

Analyses.

	Raw coal.	Washed coal.
Moisture	3.77	8.97
Volatile matter	32.65	.....
Fixed carbon	51.15	.....
Ash	13.43	8.46
Sulphur	1.79	1.56

INDIAN TERRITORY NO. 9.

Semianthracite coal from Panama, on the Kansas City Southern Railroad, was designated Indian Territory No. 9.

One sample, shipped uninspected, consisted of run-of-mine coal, and was used in steaming tests 449 and 450 (on briquets), and briquetting test 167.

CHEMICAL ANALYSES.

Indian Territory No. 9.

	Car sample.	Steaming tests.[a]	
		449.	450.
Laboratory No	4020	.....	4325
Air-drying loss	4.50	.....	.....
Proximate:			
Moisture	5.11	3.81	3.39
Volatile matter	13.65	13.62	17.15
Fixed carbon	73.21	76.16	72.04
Ash	8.03	6.41	7.42
Sulphur	1.18	1.17	1.15
Ultimate:			
Hydrogen	4.65	4.39	4.23
Carbon	78.37	84.26	82.89
Nitrogen	1.60	1.72	1.61
Oxygen	6.17	1.75	2.40
Ash	.....	6.66	7.68
Sulphur	.....	1.22	1.19
Calorific value determined (as received) (calories)	7,590	.....	.....
Calorific value determined (as received) (B. t. u.)	13,662	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Indian Territory No. 9 (run of mine).

	Test 449.	Test 450.
Size as used:		
Over 1 inch (per cent)	7.5	
½ inch to 1 inch (do)	8.1	
¼ inch to ½ inch (do)	12.4	See p. 152
Under ¼ inch (do)	72.0	
Average diameter (inch)	0.35	
Duration of test (hours)	10.2	9.97
Heating value of fuel (B. t. u. per pound dry fuel)	14,682	14,602
Force of draft:		
Under stack damper (inch water)	0.77	0.77
Above fire (do)	.14	.12

STEAMING TESTS—Continued.

Indian Territory No. 9 (run of mine).

	Test 449.	Test 450.
Furnace temperature.....°F..	2,513	2,738
Dry fuel used per square foot of grate surface per hour.....pounds..	18.62	18.47
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	3.46	3.65
Percentage of rated horsepower of boiler developed.....	97.0	102.2
Water apparently evaporated per pound of fuel as fired.....pounds..	7.51	8.00
Water evaporated from and at 212° F.:		
Per pound of fuel as fired.....do....	8.96	9.56
Per pound of dry fuel.....do....	9.31	9.89
Per pound of combustible.....do....	10.62	11.10
Efficiency of boiler, including grate.....per cent..	61.24	65.41
Fuel as fired:		
Per indicated horsepower hour.....pounds..	3.16	2.96
Per electrical horsepower hour.....do....	3.90	3.65
Dry fuel:		
Per indicated horsepower hour.....do....	3.04	2.86
Per electrical horsepower hour.....do....	3.75	3.53

Remarks.—Test 450 on briquets from test 167: Fuel burned with short flame, developing very high temperature and no smoke. A small amount of clinker was formed, which did not stick to grates.

BRIQUETTING TEST.

Indian Territory No. 9 (run of mine).

Test 167.—Size as used: Over $\frac{1}{4}$ inch, 0.8 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 3.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 12.6 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 25.2 per cent; through $\frac{1}{40}$ inch, 57.8 per cent. Excellent briquets made with 7 per cent pitch, which could be reduced by increasing pressure of machine. Briquets were hard, with smooth surface and glossy, clean fracture; easily handled from machine while hot, but became somewhat brittle when cold. For analyses of briquets see page 151 (steaming test 450).

Details of manufacture:		Drop test (1-inch screen):	
Machine used	Renf.	Held.....per cent..	62.5
Temperature of briquets.....°F..	176	Passed.....do....	37.5
Binder—		Tumbler test (1-inch screen):	
Kind	w. g. p.	Held.....do....	82.5
Laboratory No. (see p. 40).....	4120	Passed (fines).....do....	17.5
Amount.....per cent..	7	Fines through 10-mesh sieve..do....	93.0
Weight of—		Weathering test:	
Fuel briquetted.....pounds..	70,000	Time exposed.....days..	31
Briquets, average.....do....	0.459	Condition.....	B.
Heat value per pound—		Water absorption:	
Fuel as received.....B. t. u..	13,662	In 18 days.....per cent..	16.6
Fuel as fired.....do....	14,103	Average for first 5 days.....do....	2.62
Binder.....do....	17,060	Specific gravity (apparent).....	1.090

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 167.
Laboratory No.....	4120	4020	4325
Air-drying loss.....per cent..	.....	4.50	0.90
Extracted by CS_2:			
Air-dried.....do....	.....	.50	6.20
As received.....do....	97.70	.48	6.14
Pitch in briquets as received.....do....	.....	.....	5.83

KANSAS.

KANSAS NO. 2.[a]

Bituminous coal from the lower Weir-Pittsburg bed at Yale, Crawford County, was designated Kansas No. 2 B. The coal, as worked at a depth of 36 feet at this place, averages 3 feet in thickness.

One sample consisted of slack coal, shipped uninspected, and was used in steaming tests (on briquets) 487, 488, and 495; washing tests 191 and 191a; and briquetting tests 182*†, 183*, 194*, 195, 199*, 203*, and 204*.

CHEMICAL ANALYSES.

Kansas No. 2 B.

	Car sample 4361.	Steaming tests.[a]			Briquetting tests.[b]			
		487.	488.	495.	195.	199.*	203.*	204.*
Proximate:								
Moisture	8.01	9.43	4.64	7.64	4.23	2.78	2.89	3.20
Volatile matter	26.39	29.71	28.40	32.49	32.64	31.67	33.04	33.95
Fixed carbon	45.22	43.67	46.56	51.52	53.57	46.78	52.26	51.53
Ash	20.38	17.19	20.40	8.35	9.56	18.77	11.81	11.32
Sulphur	4.70	4.15	4.49	3.60	3.36	4.36	3.84	3.82
Ultimate:								
Hydrogen	.....	4.28	5.03	4.61	4.81	4.35	4.32	4.55
Carbon	.....	66.12	64.05	74.58	76.20	66.00	72.13	73.25
Nitrogen	.....	1.03	1.20	1.25	1.20	.96	1.09	1.12
Oxygen	.....	5.01	3.62	6.62	4.34	4.89	6.33	5.40
Ash	.....	18.98	21.39	9.04	9.99	19.32	12.18	11.73
Sulphur	.....	4.58	4.71	3.90	3.51	4.78	3.95	3.95

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Kansas No. 2 B (briquets).

	Test 487.	Test 488.	Test 495 (w).
Duration of test.....hours..	9.65	7.70	9.72
Heating value of fuel.....B. t. u. per pound dry fuel..	12,193	11,767	13,811
Force of draft with reference to atmospheric pressure:			
Under stack damper.....inch water..	0.82	0.80	0.84
Above fire.....do....	.17	.17	.18
Furnace temperature,.....°F..	.....	.....	2,862
Dry fuel used per square foot of grate surface per hour.....pounds..	19.43	22.00	20.30
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.10	3.44	3.81
Percentage of rated horsepower of boiler developed.....	86.8	96.6	106.8
Water apparently evaporated per pound of fuel as fired.....pounds..	5.97	6.19	7.18
Water evaporated from and at 212° F.:			
Per pound of fuel as fired.....do....	7.22	7.48	8.67
Per pound of dry fuel.....do....	7.97	7.84	9.39
Per pound of combustible.....do....	10.11	10.20	10.53
Efficiency of boiler, including grate.....per cent..	63.12	64.34	65.66
Fuel as fired:			
Per indicated horsepower hour.....pounds..	3.92	3.78	3.26
Per electrical horsepower hour.....do....	4.84	4.67	4.03
Dry fuel:			
Per indicated horsepower hour.....do....	3.55	3.61	3.01
Per electrical horsepower hour.....do....	4.38	4.45	3.72

[a] For other tests of coal from this mine, made during 1904, see Bull. U. S. Geol. Survey No. 261, 1905, pp. 44, 81, 125, 159, and Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 84, 227, 593, 1345, 1443.

Remarks.—Test 487 on briquets from test 182*†; test 488 on briquets from test 183*. English briquets fired whole burned freely with hot fire and 2.5 per cent black smoke. Renfrow briquets burned quickly with medium flame, intense heat, and no smoke. English briquets made 40 per cent and Renfrow briquets 51 per cent clinker. Clinker in both tests was very thick, nonporous, hard to break up, and nearly black in color. It did not stick to grates.

Test 495 on briquets from test 194*. Burned freely with short flame, and high furnace temperature; without breaking; made 1.5 per cent black smoke; 46 per cent clinker; ash contained unburnt, fine coal, due to disintegration of briquets during combustion. (See p. 155.)

WASHING TESTS.

Kansas No. 2 B (slack).

	Test 191.	Test 191a.		Test 191.	Test 191a.
Duration of test.....hours..	2	3¾	Raw coal.....tons..	23.00	39.00
Jig adjustment:			Washed coal.....do.....	18.1	25.25
Make or number.....	Special.	Special.	Washed coal.....per cent..	79	65
Speed.....r. p. m..	70	70	Refuse.....tons.....	4.9	13.75
Stroke.....inches..	2½	2½	Refuse.....per cent..	21	35

Analyses.

Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur.	
			Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
Raw coal, car sample.....	4361	8.01	20.38	.....	4.70	.....
Washed coal:						
Test 191.....	4410	12.11	8.88	56	3.72	21
Test 191a.....	4518	9.53	10.87	47	3.80	19
Refuse.....	.....	.....	76.50	.....	11.32	.....

Float and sink tests.

No. of test.	Specific gravity of solution used.	Percentage of float.		Sink (per cent).	Analyses.			
					Ash.		Sulphur.	
		To refuse.	To total sample.		Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
On raw coal (preliminary):								
1.....	1.36	.....	66	34	4.48	78	2.63	44
2.....	1.41	.....	74	26	5.31	74	2.78	41
3.....	1.47	.....	78	22	5.73	72	3.19	32
4.....	1.56	.....	81	19	6.18	70	3.31	30
On refuse (float)[a] of test 191:								
1.....	1.35	9	1.94	.....	4.30	.....	2.58	.....
2.....	1.40	10	2.16	.....	5.04	.....	2.92	.....
3.....	1.46	10	2.16	.....	7.53	.....	3.57	.....
4.....	1.53	10	2.16	.....	7.71	.....	3.81	.....

[a] Loss of good coal, 2.16 per cent.

BRIQUETTING TESTS.

Kansas No. 2 B.

Tests 182, 183*, 199* (raw slack).*—Size as used: Over ¼ inch, 1.0 per cent; $\frac{1}{10}$ inch to ¼ inch, 4.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 12.6 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 23.6 per cent; through $\frac{1}{40}$ inch, 58.0 per cent. Briquets showed the same characteristics as those made from washed coal, except that they were harder when cold; fracture harder and rougher, owing to high ash present. For analyses of briquets see page 153 (briquets from test 182*† under "Steaming test 487," from test 183* under "Steaming test 488").

Tests 194, 195, 203*, 204* (washed slack).*—Size as used: Over ¼ inch, 0.8 per cent; $\frac{1}{10}$ inch to ¼ inch, 4.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 12.6 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 21.4 per cent; through $\frac{1}{40}$ inch, 60.4 per cent. Satisfactory English briquets were made with 7 per cent binder and Renfrow briquets with 8 and 9 per cent binder; there being no apparent difference in these two kinds. All had smooth outer surface, were well molded, with sharp edges, clean, rough fracture, and did not break in handling while warm. After the briquets became cold those with 9 per cent binder showed less effect of abrasion than those with 8 per cent binder. Renfrow briquets showed deficiency of pressure. For analyses of briquets see page 153 (those from test 194* under "Steaming test 495").

	From raw slack.			From washed slack.			
	Test 182*†.	Test 183*.	Test 199*.	Test 194*.	Test 195.	Test 203*.	Test 204*.
Details of manufacture:							
Machine used	Eng.	Renf.	Renf.	Eng.	Eng.	Renf.	Renf.
Temperature of briquets ..... ° F.	158	149	149	176	176	149	149
Binder—							
Kind	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4543	4543	4683	4543	4683	4683	4683
Amount ..... per cent.	7	7	8	7	7	8	9
Weight of—							
Fuel briquetted ..... pounds.	40,000	40,000	68,000	12,000	24,000	16,000	24,000
Briquets, average ..... do.	3.95	0.482	0.455	3.65	3.61	0.441	0.417
Heat value per pound—							
Fuel as received ..... B. t. u.	10,640	10,640	10,640	13,243	13,243	13,243	13,243
Fuel as fired ..... do.	11,043	11,221	11,795	12,841	12,982	13,012	13,104
Binder ..... do.	16,969	16,969	16,637	16,969	16,637	16,637	16,637
Drop test (1-inch screen):							
Held ..... per cent.	89.1	69.0	61.0	84.9	81.4	64.0	52.5
Passed ..... do.	10.9	31.0	39.0	15.1	18.6	36.0	47.5
Tumbler test (1-inch screen):							
Held ..... do.	85.2	91.0	88.5	80.8	83.5	84.5	80.5
Passed (fines) ..... do.	14.8	9.0	11.5	19.2	16.5	15.5	19.5
Fines through 10-mesh sieve ..... do.	71.6	94.7	97.5	87.2	74.6	94.7	94.3
Weathering test:							
Time exposed ..... days.	12	12	.....	4	3	.....	.....
Condition	B.	A.	.....	A.	A.	.....	.....
Water absorption:							
In 19 days ..... per cent.	9.2	12.6	.....	.....	.....	.....	.....
In 13 days ..... do.	.....	.....	12.4	8.7	9.7	13.6	12.9
Average for first 4 days ..... do.	1.15	1.95	2.23	1.35	1.43	2.50	2.23
Specific gravity (apparent)	1.198	1.170	1.143	1.122	1.105	1.044	1.098

Extraction analyses.

	Pitches.		Fuel.		Briquets.						
					Test 182*†.	Test 183*.	Test 199*.	Test 194*.	Test 195.	Test 203*.	Test 204*.
Laboratory No.	4543	4683	4361	4518	4374	4380	.....	4422	4660	4654	4655
Air-drying loss ..... per cent.	.....	.....	6.60	8.20	7.00	3.00	.....	6.20	.....	.....	.....
Extracted by CS_2:											
Air-dried ..... do.	.....	.....	.50	.59	7.12	6.99	.....	7.14	.....	.....	.....
As received ..... do.	99.66	89.31	.47	.54	6.62	6.78	6.61	6.70	6.60	7.02	7.83
Pitch in briquets as received, per cent	.....	.....	.....	.....	6.21	6.36	6.91	6.30	6.83	7.30	8.21

KANSAS NO. 6.

Bituminous coal from Jewett, Linn County, on the Missouri Pacific Railroad, was designated Kansas No. 6. The coal, as worked at a depth of 88 feet at this place, averages 2 feet 10 inches in thickness.

This sample, shipped under the supervision of W. J. Von Borries, consisted of lump coal over a 1¼-inch bar screen and was used in making steaming tests 311 and 323; producer-gas test 101; washing test 148; coking tests 113 (raw) and 115 (washed); and cupola test 122 (washed coal).

Two mine samples were taken for chemical analysis. Sample 2790 was cut 2,000 feet northeast of the shaft, where the coal measured 2 feet 10 inches in thickness. Sample 2791 was cut 1,200 feet northwest of the bottom of the shaft, where the coal measured 2 feet 3 inches in thickness.

CHEMICAL ANALYSES.

Kansas No. 6.

	Mine samples.		Car sample.	Steaming tests.[a]	
				311.	323.
Laboratory No	2790	2791	2843		
Air-drying loss	9.20	7.60	7.10		
Proximate:					
Moisture	11.13	10.12	9.04	8.28	11.71
Volatile matter	28.83	30.25	29.69	30.33	30.23
Fixed carbon	47.44	46.82	45.55	45.86	47.61
Ash	12.60	12.81	15.72	15.53	10.45
Sulphur	2.41	2.66	3.72	3.42	2.64
Ultimate:					
Hydrogen			5.01	4.45	4.78
Carbon			60.99	67.64	72.62
Nitrogen			1.06	1.18	1.26
Oxygen			13.50	6.07	6.52
Ash				16.93	11.83
Sulphur				3.73	2.99
Calorific value (as received):					
Determined, calories	6,233		6,190		
Determined, B. t. u.	11,219		11,142		
Calculated from ultimate analysis, calories			6,156		
Calculated from ultimate analysis, B. t. u.			11,081		

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Kansas No. 6 (lump).

	Test 311.	Test 323 (w.).
Size as used:		
Over 1 inch, per cent	42.8	38.7
½ inch to 1 inch, do	21.4	25.3
¼ inch to ½ inch, do	13.7	17.7
Under ¼ inch, do	22.1	18.3
Duration of test, hours	9.98	7.20
Heating value of coal, B. t. u. per pound dry coal	12,343	13,135
Force of draft:		
Under stack damper, inch water	0.58	0.52
Above fire, do	.13	.15
Furnace temperature, °F	2,313	2,670
Dry coal used per square foot of grate surface per hour, pounds	18.62	22.34

STEAMING TESTS—Continued.

Kansas No. 6 (lump).

	Test 311.	Test 323 (w.)
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	2.93	3.80
Percentage of rated horsepower of boiler developed	82.2	106.6
Water apparently evaporated per pound of coal as fired....pounds..	6.03	6.24
Water evaporated from and at 212° F.:		
Per pound of coal as fired....do....	7.23	7.53
Per pound of dry coal....do....	7.88	8.52
Per pound of combustible....do....	9.89	9.92
Efficiency of boiler, including grate....per cent..	61.65	62.64
Coal as fired:		
Per indicated horsepower hour....pounds..	3.91	3.75
Per electrical horsepower hour....do....	4.83	4.64
Dry coal:		
Per indicated horsepower hour....do....	3.59	3.32
Per electrical horsepower hour....do....	4.43	4.10

PRODUCER-GAS TEST.

Kansas No. 6 (lump).

Test 101.—Size as used: Over 1 inch, 64 per cent; ½ inch to 1 inch, 17 per cent; ¼ inch to ½ inch, 9 per cent; under ¼ inch, 10 per cent. Duration of test, 13⅔ hours. Average electrical horsepower, 198.9. Average b. t. u. gas per cubic foot, 155.2. Total coal fired, 4,500 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.73	1.56	1.33
Developed at switchboard	1.66	1.49	1.27
Per brake horsepower:			
Commercially available	1.47	1.33	1.13
Developed at engine	1.41	1.27	1.08
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.84	1.66	1.41
Developed at switchboard	1.76	1.58	1.35
Per brake horsepower:			
Commercially available	1.56	1.41	1.20
Developed at engine	1.49	1.35	1.15

Analyses.

Coal.		*Gas by volume.*	
Moisture	9.85	Carbon dioxide (CO_2)	8.2
Volatile matter	30.19	Carbon monoxide (CO)	21.0
Fixed carbon	46.68	Hydrogen (H_2)	12.7
Ash	13.28	Methane (CH_4)	2.1
Sulphur	3.04	Nitrogen (N_2)	55.4
		Ethylene (C_2H_4)	.6

WASHING AND COKING TESTS.

Kansas No. 6 (lump).

Washing test 148.—Size as used, crushed to 2-inch. Jig used, Stewart. Raw coal, 24,000 pounds; washed, 22,000 pounds; refuse, 2,000 pounds.

Coking tests.

	Test 113 (raw).	Test 115 (w.).
Size as used	f. c.	f. c.
Duration of test, hours	47	49
Coal charged, pounds	10,000	12,000
Coke produced, do	5,443	6,439
Coke produced, per cent	54.43	53.66
Breeze produced, pounds	341	299
Breeze produced, per cent	3.41	2.49
Total yield, do	57.84	56.15

Remarks.—Test 113: Light-gray color; strong, heavy coke; ash and sulphur high. Test 115: Light gray and silvery; strong, heavy coke; ash and sulphur reduced by washing (compare test 113), but still high.

Analyses.

	Washing test 148.		Coking test 113.		Coking test 115.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	9.04	12.63	8.58	1.01	12.29	0.59
Volatile matter	29.69	.....	30.27	.64	30.30	.56
Fixed carbon	45.55	.....	45.92	75.07	47.21	82.78
Ash	15.72	10.16	15.23	23.28	10.20	16.07
Sulphur	3.72	2.47	3.47	3.45	2.63	2.49

Cupola test of coke made from Kansas No. 6 coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Coke.[a] Specific gravity.	Coke.[a] Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
122	115	1.90	7	97.22	Coke	180	63	63	62	62	430
					Pig iron	540	428	428	427	427	2,250
					Scrap	180	143	143	142	142	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	Min.	Lbs.	Lbs.	Lbs.	Min.	Lbs.		Per ct.	Lbs.	Lbs.
122	8.57 a. m.	7	7	1,468	230	1,698	33	3,087	5.70	6.80	1,098	132

LADLE RECORD.

Ladle No.	Pounds.	Time (a. m.).	Ladle No.	Pounds.	Time (a. m.).
1	133	9.16	10	80	9.26
2	111	9.16½	11	99	9.27
3	102	9.19½	12	82	9.28
4	83	9.20	13	61	9.34
5	100	9.22	14	75	9.35
6	98	9.22½	15	71	9.36
7	89	9.23	16	47	9.36½
8	103	9.23½	17	54	9.37
9	80	9.24			

[a] Sulphur in ash, 0.02 per cent.

KENTUCKY.

KENTUCKY NO. 2.[a]

Coke breeze from Earlington, Hopkins County, on the Louisville and Nashville Railroad, was designated Kentucky No. 2 B. A sample shipped uninspected was used in washing test 143, in briquetting test 102, and mixed with Illinois No. 20 in briquetting tests 103 and 104 (p. 88).

WASHING TEST.

Kentucky No. 2 B (coke breeze).

Test 143.—Jig used, Stewart. Ash: Raw, 46.30 per cent; washed, 26.10 per cent reduction, 44 per cent.

BRIQUETTING TEST.

Kentucky No. 2 B (coke breeze).

Test 102.—Size as used: Over $\frac{1}{4}$ inch, 10.25 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 31 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 18.75 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 18.55 per cent; through $\frac{1}{40}$ inch, 21.45 per cent. Machine used, English; temperature of briquets, 179.6° F. Binder: Kind, c. t. p. and w. g. p.; amount, 6 and 7 per cent. Weight of fuel briquetted, 50,000 pounds.

Briquets were soft when hot, but on cooling were hard enough to handle satisfactorily. Various mixtures made no apparent difference. All briquets showed coarse structure and were easily fractured. Attempted boiler tests were discontinued owing to difficulty in maintaining steam. Broken briquets burned better than whole ones. For pitch analyses see page 40 (Nos. 2729, 2735, and 2748). All these briquets were sent to the Big Four Railway for preliminary locomotive test. The results were unsatisfactory.

KENTUCKY NO. 8.

Bituminous coal from bed No. 1 B, or "Bell-coal" bed, at Sturges, Union County, on the Illinois Central Railroad, was designated Kentucky No. 8. The coal, as worked at a depth of 40 feet at this place, averages 2 feet 8 inches in thickness.

One sample, shipped under the supervision of F. B. Tough, consisted of run-of-mine coal, and was used in steaming tests 434 and 443; coking tests 164 and 165; and cupola tests 147, 155, and 156.

Two mine samples were taken for chemical analysis. Sample 3678 was taken 100 feet north of the opening, where the coal measured 2 feet 7¼ inches in thickness. Sample 3679 was taken 60 feet north of the opening, where the coal measured 2 feet 9¼ inches in thickness.

[a] For results of earlier tests of Kentucky No. 2 coal, see Bull. U. S. Geol. Survey No. 261, 1905, pp. 46, 81, 159; and Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 91, 232, 649, 1348, 1444.

CHEMICAL ANALYSES.

Kentucky No. 8.

	Mine samples.		Car sample.	Steaming tests.[a]	
				434.	443.
Laboratory No.	3678	3679	3860	.....	.....
Air-drying loss	5.10	5.70	3.20	.....	.....
Proximate:					
Moisture	7.46	8.09	5.46	5.76	5.53
Volatile matter	30.69	30.10	30.99	30.36	29.68
Fixed carbon	57.25	56.65	55.63	56.21	57.05
Ash	4.60	5.16	7.92	7.67	7.74
Sulphur	.97	1.07	1.18	1.28	1.10
Ultimate:					
Hydrogen	.....	.....	5.07	4.72	4.73
Carbon	.....	.....	72.59	76.87	77.01
Nitrogen	.....	.....	1.19	1.26	1.26
Oxygen	.....	.....	12.05	7.65	7.65
Ash	.....	.....	.....	8.14	8.19
Sulphur	.....	.....	.....	1.36	1.16
Calorific value determined (as received) calories	7,494	.....	7,355	.....	.....
Calorific value determined (as received) B. t. u.	13,489	.....	13,239	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Kentucky No. 8.

	Test 434.	Test 443.
Size as used:		
Over 1 inch ..... per cent	29.9	27.7
½ inch to 1 inch ..... do	23.4	20.6
¼ inch to ½ inch ..... do	15.6	15.4
Under ¼ inch ..... do	31.1	36.3
Average diameter ..... inch	0.77	0.80
Duration of test ..... hours	9.1	9.72
Heating value of coal ..... B. t. u. per pound dry coal	14,026	14,044
Force of draft:		
Under stack damper ..... inch water	0.66	0.79
Above fire ..... do	.05	.14
Furnace temperature ..... ° F	.....	2,778
Dry coal used per square foot of grate surface per hour ..... pounds	19.65	20.12
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.57	3.71
Percentage of rated horsepower of boiler developed	100.0	104.1
Water apparently evaporated per pound of coal as fired ..... pounds	7.35	7.44
Water evaporated from and at 212° F.:		
Per pound of coal as fired ..... do	8.56	8.73
Per pound of dry coal ..... do	9.08	9.24
Per pound of combustible ..... do	10.12	10.36
Efficiency of boiler, including grate ..... per cent	62.52	63.54
Coal as fired:		
Per indicated horsepower hour ..... pounds	3.30	3.24
Per electrical horsepower hour ..... do	4.08	4.00
Dry coal:		
Per indicated horsepower hour ..... do	3.11	3.06
Per electrical horsepower hour ..... do	3.84	3.78

COKING TESTS.

Kentucky No. 8.

	Test 164.	Test 165.
Size as shipped	r. o. m.	r. o. m.
Size as used	f. c.	f. c.
Duration of test ..... hours	49	51
Coal charged ..... pounds	12,450	12,840
Coke produced ..... do	7,200	7,845
Coke produced ..... per cent	57.83	61.10
Breeze produced ..... pounds	371	361
Breeze produced ..... per cent	2.98	2.81
Total yield ..... do	60.81	63.91

Remarks.—Test 164: Gray color, with a little silvery deposit of carbon; breakage good, regular-sized pieces; cell structure large. Test 165: Gray color, with a little silvery deposit of carbon; breakage good, large pieces of regular size; cell structure large. Some improvement over test 164; yield somewhat higher, with increase in ash and sulphur.

Analyses.

	Test 164.		Test 165.	
	Coal.	Coke.	Coal.	Coke.
Moisture	4.97	0.50	5.49	0.47
Volatile matter	30.87	.65	30.36	.50
Fixed carbon	56.66	87.96	55.49	86.10
Ash	7.50	10.89	8.66	12.93
Sulphur	1.23	.93	1.27	1.14

Cupola tests of coke made from Kentucky No. 8 coal.

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
147	164	1.90	7	97.22	Coke	200	58	58	57	57	430
					Pig iron	800	550	550	550	550	3,000
155	164	1.90	6	93.05	Coke	210	73	73	72	72	500
					Pig iron	840	540	540	540	540	3,000
156	164	1.90	8	93.06	Coke	200	44	44	44	43	375
					Pig iron	800	550	550	550	550	3,000

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
147	3.30 p. m.	7	11	1,556	403	1,959	31	3,791	5.53	4.70	900	76
155	3.40 p. m.	7	8	2,101	361	2,462	38	3,887	5.85	5.93	360	79
156	10.56 a. m.	7	11	2,124	203	2,327	32	4,551	7.94	5.80	499	82

SILICON, MANGANESE, ETC.

Cupola test No.	Materials.	Amount used (pounds).	Silicon. Per cent.	Silicon. Pounds.	Manganese. Per cent.	Manganese. Pounds.	Sulphur. Per cent.	Sulphur. Pounds.	Content of coke combined with iron melted (per cent).
147	Pig iron		2.12	41.53	0.178	3.487	0.59	1.1558	4.65
	Melted iron:								
	Amount		1.80	35.26	.096	1.881	.067	1.3125	
	Gain or loss		−15.12	− 6.27	−46.06	−1.606	+.008	+ .1567	
	Coke	362					.93	3.3666	
155	Pig iron		2.12	52.19	.178	4.382	.059	1.4526	12.37
	Melted iron:								
	Amount		1.72	42.35	.123	3.028	.079	1.9450	
	Gain or loss		−18.85	− 9.84	−30.90	−1.354	+.020	+ .4924	
	Coke	429					.93	3.9897	
156	Pig iron		2.12	49.33	.178	4.142	.059	1.3729	19.95
	Melted iron:								
	Amount		1.82	42.35	.111	2.583	.083	1.9314	
	Gain or loss		−14.15	− 6.98	−37.64	−1.559	+.024	+ .5585	
	Coke	301					.93	2.7993	

Cupola tests of coke made from Kentucky No. 8 coal—Continued.

LADLE RECORD.

Ladle No.	Test 147. Pounds.	Test 147. Time (p.m.).	Test 155. Pounds.	Test 155. Time (p. m.).	Test 156. Pounds.	Test 156. Time (a. m.).	Ladle No.	Test 147. Pounds.	Test 147. Time (p. m.).	Test 155. Pounds.	Test 155. Time (p. m.).	Test 156. Pounds.	Test 156. Time (a. m.).
1	86	3.47	67	3.54	32	11.10	14	86	4.08	106	4.12	107	11.28
2	86	3.47½	97	3.57	94	11.13	15	90	4.08½	85	4.14	94	11.29
3	40	3.48	39	3.57½	82	11.13½	16	84	4.09	81	4.14½	91	11.29½
4	72	3.52	81	4.00	70	11.18	17	82	4.11	105	4.15	93	11.30
5	91	3.52½	113	4.01	102	11.18½	18	44	4.12	76	4.17	89	11.32
6	94	3.53	85	4.03	100	11.19	19	.....	.....	76	4.17½	102	11.32½
7	67	3.56	87	4.03½	70	11.22	20	.....	.....	104	4.18	100	11.33
8	102	3.56½	103	4.04	101	11.22½	21	.....	.....	66	4.23	85	11.36
9	98	3.57	90	4.07	102	11.23	22	.....	.....	64	4.23½	100	11.36½
10	88	4.03	79	4.07½	59	11.24	23	.....	.....	85	4.24	103	11.37
11	84	4.03½	108	4.08	104	11.24½	24	.....	.....	65	4.25	75	11.39
12	94	4.04	84	4.11	92	11.27	25	.....	.....	55	4.25½	.....	.....
13	168	4.04½	75	4.11½	77	11.27½	26	.....	.....	25	4.26	.....	.....

Remarks.—Tests 147, 155, 156: Pig iron used from car 27633; temperature of iron, medium.

KENTUCKY NO. 9.

Bituminous coal from bed No. 9, at McHenry, Ohio County, on the Illinois Central Railroad, was designated Kentucky No. 9. The coal, as mined at a depth of 50 feet at this place, averages 4 feet 6 inches in thickness.

Two samples were shipped under the supervision of K. M. Way, as follows: Kentucky No. 9 A consisted of nut coal through a 1¼-inch screen and over a ⅜-inch screen, and was used in washing test 182, coking test 167, and cupola tests 149, 162, and 163. Kentucky No. 9 B consisted of run-of-mine coal, and was used in steaming test 462.

Two mine samples were taken for chemical analysis. Sample 3722 was taken 200 feet north of the shaft, where the coal measured 4 feet 6 inches in thickness. Sample 3723 was taken 550 feet north of the shaft, where the coal measured 4 feet 5¾ inches in thickness.

CHEMICAL ANALYSES.

Kentucky No. 9.

	Mine samples.		Car sample (A).	Steaming test 462.[a]
Laboratory No	3722	3723	3865	.....
Air-drying loss	3.30	2.90	3.50	.....
Proximate:				
Moisture	10.03	9.89	8.70	8.04
Volatile matter	36.06	35.70	35.00	32.63
Fixed carbon	46.24	45.72	47.34	49.28
Ash	7.67	8.69	8.96	10.05
Sulphur	2.56	2.45	3.14	2.97
Ultimate:				
Hydrogen	.....	.....	5.61	4.83
Carbon	.....	.....	65.63	71.12
Nitrogen	.....	.....	1.20	1.45
Oxygen	.....	.....	15.46	8.44
Ash	.....	.....	.....	10.93
Sulphur	.....	.....	.....	3.23
Calorific value determined (as received) calories	6,709	6,626	6,710	.....
Calorific value determined (as received) B. t. u.	12,076	11,927	12,078	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Kentucky No. 9 B.

	Test 462.
Size as used:	
Over 1 inch ..... per cent	32.3
½ inch to 1 inch ..... do	26.4
¼ inch to ½ inch ..... do	16.6
Under ¼ inch ..... do	24.7
Average diameter ..... inch	0.83
Duration of test ..... hours	10
Heating value of coal ..... B. t. u. per pound dry coal	13,084
Force of draft:	
Under stack damper ..... inch water	0.70
Above fire ..... do	.19
Furnace temperature ..... °F	2,742
Dry coal used per square foot of grate surface per hour ..... pounds	21.48
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	3.69
Percentage of rated horsepower of boiler developed	103.5
Water apparently evaporated per pound of coal as fired ..... pounds	6.55
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... do	7.92
Per pound of dry coal ..... do	8.61
Per pound of combustible ..... do	9.97
Efficiency of boiler, including grate ..... per cent	63.55
Coal as fired:	
Per indicated horsepower hour ..... pounds	3.57
Per electrical horsepower hour ..... do	4.41
Dry coal:	
Per indicated horsepower hour ..... do	3.28
Per electrical horsepower hour ..... do	4.05

WASHING AND COKING TESTS.

Kentucky No. 9 A (nut).

Washing test 182.—Jig used, Stewart. Raw coal, 19,125 pounds; washed coal, 15,698 pounds, 82 per cent; refuse, 3,427 pounds, 18 per cent.

Coking test 167.—Size as used, washed, finely crushed. Duration of test, 51 hours. Coal charged, 12,190 pounds. Coke produced, 6,360 pounds, 52.17 per cent. Breeze produced, 309 pounds, 2.54 per cent. Total yield, 54.71 per cent. Light gray and silvery; fine-fingered coke; high in sulphur; good coke.

Analyses.

	Washing test 182.		Coking test 167.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	8.70	9.09	9.12	1.01
Volatile matter	35.00	.....	35.42	.69
Fixed carbon	47.34	.....	47.88	86.46
Ash	8.96	7.22	7.58	11.84
Sulphur	3.14	2.61	2.58	1.96

Cupola tests of coke made from Kentucky No. 9 A coal (washed).

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Ratio, iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
149	167	1.86	7	95.83	Coke	170	65	65	65	65	430
					Pig iron	680	580	580	580	580	3,000
162	167	1.86	8	94.44	Coke	170	52	51	51	51	375
					Pig iron	680	580	580	580	580	3,000
163	167	1.86	6	98.61	Coke	190	78	78	77	77	500
					Pig iron	760	560	560	560	560	3,000

Cupola tests of coke made from Kentucky No. 9 A coal (washed)—Continued.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Ratio per hour.	Melting. Ratio, iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
149	3.08 p. m....	7	9	2,282	228	2,510	28	5,378	6.66	8.0	250	53
162	10.45 a. m...	7	10	2,161	356	2,517	32	4,719	7.70	5.47	319	48
163	3.35 p. m....	7	10	2,230	123	2,353	42	3,361	5.00	2.97	558	29

SILICON, MANGANESE, ETC.

Cupola test No.	Materials.	Amount used (pounds).	Silicon. Per cent.	Silicon. Pounds.	Manganese. Per cent.	Manganese. Pounds.	Sulphur. Per cent.	Sulphur. Pounds.	Content of coke combined with iron melted (per cent).
149	Pig iron		2.12	53.21	0.178	4.468	0.059	1.4809	
	Melted iron:								
	Amount		1.83	45.93	133	3.338	.079	1.9829	6.69
	Gain or loss		−13.68	− 7.28	−25.29	−1.130	+ .020	+ .5020	
	Coke	383					1.96	7.5068	
162	Pig iron		2.10	52.86	.163	4.103	.098	2.4667	
	Melted iron:								
	Amount		1.76	44.30	.120	3.020	.118	2.9701	7.73
	Gain or loss		−16.19	− 8.56	−26.39	−1.083	+ .020	+ .5034	
	Coke	332					1.96	6.5072	
163	Pig iron		2.10	49.41	.163	3.835	.098	2.4059	
	Melted iron:								
	Amount		1.73	40.71	.096	2.259	.135	3.1765	8.29
	Gain or loss		−17.61	− 8.70	−41.09	−1.576	+ .037	+ .7706	
	Coke	474					1.96	9.2924	

LADLE RECORD.

Ladle No.	Test 149. Lbs.	Test 149. Time (p.m.).	Test 162. Lbs.	Test 162. Time (a.m.).	Test 163. Lbs.	Test 163. Time (p.m.).	Ladle No.	Test 149. Lbs.	Test 149. Time (p.m.).	Test 162. Lbs.	Test 162. Time (a.m.).	Test 163. Lbs.	Test 163. Time (p.m.).
1	90	3.23	84	11.00	66	3.49	14	106	3.34	84	11.14½	136	4.12
2	50	3.23½	96	11.03	114	3.51	15	83	3.35	100	11.15	86	4.17
3	78	3.25	105	11.03½	110	3.54	16	96	3.35½	80	11.18	95	4.17½
4	96	3.25½	96	11.04	103	3.55	17	110	3.36	86	11.18½	130	4.18
5	69	3.26	80	11.07	30	3.55½	18	83	3.37	96	11.19	90	4.24
6	88	3.28	101	11.07½	128	4.02	19	104	3.37½	126	11.23	148	4.24½
7	102	3.28½	89	11.08	96	4.02½	20	102	3.39	69	11.23½	98	4.25
8	118	3.29	82	11.09	97	4.03	21	78	3.39½	79	11.24	88	4.26
9	91	3.31	97	11.09½	100	4.07	22	97	3.40	66	11.25	98	4.27
10	100	3.31½	82	11.11	91	4.07½	23	97	3.41	130	11.26	.....	.....
11	115	3.32	83	o11.11½	126	4.08	24	67	3.43	69	11.27	.....	.....
12	79	3.33	93	11.12	100	4.11	25	85	3.45	.....	.....	.....	.....
13	98	3.33½	88	11.14	100	4.11½							

Remarks.—Test 149: Pig iron used from car 27633. Iron hot. Tests 162 and 163: Pig iron used from car 131943. Temperature of iron, medium.

MARYLAND.

MARYLAND NO. 2.

Bituminous coal from the Big vein or Pittsburg bed at Frostburg, Allegany County, on the Baltimore and Ohio Railroad was designated Maryland No. 2. The coal, as worked from the outcrop at this place, averages 8 feet 10 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of run-of-mine coal and was used in steaming tests 490, 493 (on briquets), and 518 (on briquets), and briquetting tests 191, 192, 193, and 231†.

Two mine samples were taken for chemical analysis. Sample 4334 was taken 6,600 feet southwest of the opening, where the coal measured 9 feet 4 inches in thickness. Sample 4335 was taken 4,500 feet south of the opening, where the coal measured 8 feet 3¾ inches in thickness.

CHEMICAL ANALYSES.

Maryland No. 2.

	Mine samples.		Steaming tests.[a]				Steaming tests.[a]		
			490.	493.	518.		490.	493.	518.
Laboratory No	4334	4335	.....	4415	4767	Ultimate:			
Air-drying loss	2.00	1.80	.....	.....	.....	Hydrogen	4.44	4.33	4.61
Proximate:						Carbon	82.18	81.52	83.26
Moisture	2.54	2.47	2.35	6.83	4.21	Nitrogen	1.48	1.79	1.64
Volatile matter	18.23	18.17	16.97	19 71	20:71	Oxygen	2.77	3.44	2.68
Fixed carbon	73.09	73.06	72.53	66.01	68.54	Ash	8.35	8.00	6.83
Ash	6.14	6.30	8.15	7.45	6.54	Sulphur	.78	.92	.98
Sulphur	.87	.79	.76	.86	.94				

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Maryland No. 2.

	Test 490.	Test 493.	Test 518.
Size as used:			
Over 1 inch.....per cent..	17.4		
½ inch to 1 inch.....do....	20.8		
¼ inch to ½ inch.....do....	20.2	See p. 166.	See p. 166.
Under ¼ inch.....do....	41.6		
Average diameter.....inch..	.60		
Duration of test.....hours..	9.63	10.00	5.42
Heating value of fuel.....B. t. u. per pound dry fuel..	14,515	14,576	14,717
Force of draft:			
Under stack damper.....inch water..	0.83	0.85	0.29
Above fire.....do....	.22	.21	.16
Dry fuel used per square foot of grate surface per hour.....pounds..	20.12	21.13	22.81
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	4.06	4.32	2.44
Percentage of rated horsepower of boiler developed.....	113.9	121.2	68.4
Water apparently evaporated per pound of fuel as fired.....pounds..	8.16	7.87	8.45
Water evaporated from and at 212° F.:			
Per pound of fuel as fired.....do....	9.87	9.52	10.25
Per pound of dry fuel.....do....	10.11	10.22	10.70
Per pound of combustible.....do....	11.24	11.35	12.23
Efficiency of boiler, including grate.....per cent..	67.26	67.71	70.21
Fuel as fired:			
Per indicated horsepower hour.....pounds..	2.87	2.97	2.76
Per electrical horsepower hour.....do....	3.54	3.67	3.41
Dry fuel:			
Per indicated horsepower hour.....do....	2.80	2.77	2.64
Per electrical horsepower hour.....do....	3.45	3.42	3.26

Remarks.—Test 493 on equal weights of briquets from tests 191, 192, and 193; test 518 on briquets from test 231†; grate area reduced to 20.3 square feet. Square briquets were fired whole, burned freely, with intense heat, and no smoke. Bed more uniform with round briquets and temperature higher; no smoke. Square briquets made 56 per cent clinker; round briquets made 47 per cent clinker.

BRIQUETTING TESTS.

Maryland No. 2 (run of mine).

Tests 191, 192, 193, 231†.—Size as used: Over $\frac{1}{4}$ inch, 2.2 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 9.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 26 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 28.2 per cent; through $\frac{1}{40}$ inch, 33.8 per cent. Various proportions of binder (5, 6, and 7 per cent) made equally good briquets on English machine. Briquet surfaces were smooth, firm, with characteristic glossy fracture, and sharp edges. Renfrow briquets were satisfactory, but owing to faulty operation in heater best results were not obtained. Excellent briquets can be made from this coal with 5 per cent of binder. For analyses of briquets see page 165 (briquets from test 191, 192, and 193 under "Steaming test 493," from test 231† under "Steaming test 518").

	Test 191.	Test 192.	Test 193.	Test 231†.
Details of manufacture:				
Machine used	Eng.	Eng.	Eng.	Renf.
Temperature of briquets °F.	185	185	185	131
Binder—				
Kind	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4543	4543	4543	4806
Amount per cent.	5	6	7	8
Weight of—				
Fuel briquetted pounds.	4,000	4,000	4,000	17,000
Briquets, average do.	3.35	3.32	3.47	0.453
Heat value per pound—				
Fuel as received B. t. u.	14,162	14,162	14,162	14,162
Fuel as fired do.	13,581	13,581	13,581	14,098
Binder do.	16,969	16,969	16,969	16,864
Drop test (1-inch screen):				
Held per cent.	75.9	79.3	82.5	24.0
Passed do.	21.1	20.7	17.5	76.0
Tumbler test (1-inch screen):				
Held do.	74.0	78.2	80.2	66.5
Passed (fines) do.	26.0	21.8	19.8	33.5
Fines through 10-mesh sieve do.	75.6	77.8	63.0	85.0
Weathering test:				
Time exposed days.	5	5	5	.....
Condition	A.	A.	A.	.....
Water absorption:				
In 19 days per cent.	11.9	15.6	10.5	14.4
Average for first 4 days do.	1.45	1.85	1.30	2.25
Specific gravity (apparent)	1.118	1.076	1.143	1.071

Extraction analyses.

	Pitches.	Fuel.		Briquets.	
				Tests 191, 192, 193.	Test 231†.
Laboratory No.	4543	4806	4335	4415	4767
Air-drying loss per cent.	.....	.....	1.80	6.00	3.40
Extracted by CS_2:					
Air-dried do.	.....	.....	.21	5.77	7.88
As received do.	99.66	96.90	.20	5.42	7.61
Pitch in briquets as received do.	.....	.....	.....	5.25	7.69

MISSOURI.

MISSOURI NO. 5.

Bituminous coal from Higbee, Randolph County, on the Chicago and Alton Railroad, was designated Missouri No. 5. The coal, as worked at a depth of 170 feet at this place, averages 3 feet 10 inches in thickness.

This sample, shipped under the supervision of John W. Groves, consisted of run-of-mine coal and was used in steaming tests 319 and 320, washing test 149, coking test 116 (washed coal), and cupola test 123.

Two mine samples were taken for chemical analysis. Sample 2795 was cut 3,400 feet northwest of the shaft, where the coal measured 3 feet 10 inches in thickness. Sample 2796 was cut 5,000 north of the shaft, where the coal measured 3 feet 10 inches in thickness.

CHEMICAL ANALYSES.

Missouri No. 5.

	Mine samples.		Car sample.	Steaming tests.[a]	
				319.	320.
Laboratory No	2795	2796	2865	.....	.....
Air-drying loss	10.80	11.50	11.40	.....	.....
Proximate:					
Moisture	13.38	13.89	12.92	13.37	12.24
Volatile matter	34.17	33.36	33.64	31.46	31.55
Fixed carbon	42.43	41.23	39.82	39.78	40.10
Ash	10.02	11.52	13.62	15.39	16.11
Sulphur	4.48	4.19	5.03	5.35	5.33
Ultimate:					
Hydrogen	.....	.....	5.43	4.43	4.40
Carbon	.....	.....	57.16	63.53	63.13
Nitrogen	.....	.....	.90	1.01	1.00
Oxygen	.....	.....	17.86	7.90	7.04
Ash	.....	.....	.....	17.76	18.36
Sulphur	.....	.....	.....	6.18	6.07
Calorific value (as received):					
Determined (calories)	6,158	.....	5,860	.....	.....
Determined (B. t. u.)	11,084	.....	10,548	.....	.....
Calculated from ultimate analysis (calories)	.....	.....	5,834	.....	.....
Calculated from ultimate analysis (B. t. u.)	.....	.....	10,501	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Missouri No. 5 (run of mine).

	Test 319.	Test 320.
Size as used:		
Over 1 inch, per cent	23.5	20.1
½ inch to 1 inch, do	22.9	21.0
¼ inch to ½ inch, do	19.3	18.8
Under ¼ inch, do	34.3	40.1
Duration of test, hours	9.63	8.35
Heating value of coal, B. t. u. per pound dry coal	11,747	11,668
Force of draft:		
Under stack damper, inch water	0.61	0.73
Above fire, do	.22	.34
Furnace temperature, °F.	2,368	.....
Dry coal used per square foot of grate surface per hour, pounds	18.64	22.24
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	2.79	3.38

STEAMING TESTS—Continued.

Missouri No. 5 (run of mine).

	Test 319.	Test 320.
Percentage of rated horsepower of boiler developed	87.1	94.7
Water apparently evaporated per pound of coal as fired...pounds..	5.39	5.54
Water evaporated from and at 212° F:		
Per pound of coal as fired...do....	6.49	6.67
Per pound of dry coal...do....	7.49	7.60
Per pound of combustible...do....	9.36	9.60
Efficiency of boiler, including grate...per cent..	61.57	62.90
Coal as fired:		
Per indicated horsepower hour...pounds..	4.36	4.24
Per electrical horsepower hour...do....	5.38	5.24
Dry coal:		
Per indicated horsepower hour...do....	3.77	3.72
Per electrical horsepower hour...do....	4.66	4.59

WASHING AND COKING TESTS.

Missouri No. 5 (run of mine).

Washing test 149.—Size as used, crushed to 2-inch. Jig used, Stewart. Raw coal, 15,300 pounds; washed coal, 12,900 pounds; refuse, 2,400 pounds.

Coking test 116.—Size as used, washed, finely crushed. Duration of test, 33 hours. Coal charged, 10,000 pounds. Coke produced, 4,903 pounds; 49.03 per cent. Breeze produced, 299 pounds; 2.99 per cent. Total yield, 52.02 per cent. Light gray and silvery. Washing does not sufficiently reduce ash and sulphur; too high in sulphur for metallurgical purposes.

Analyses.

	Washing test 149.		Coking test 116.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	12.92	13.93	13.68	1.12
Volatile matter	33.64	.....	34.82	.73
Fixed carbon	39.82	.....	42.26	82.64
Ash	13.62	9.08	9.24	15.51
Sulphur	5.03	3.62	3.60	3.40

Cupola test of coke made from Missouri No. 5 coal (washed).

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
123	116	1.88	7	92.36	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
123	3.16 p. m.	7	5	1,964	423	2,387	34	4,212	6.25	9.06	341	48

Cupola test of coke made from Missouri No. 5 coal (washed)—Continued.

LADLE RECORD.

Ladle No.	Test 123.		Ladle No.	Test 123.	
	Pounds.	Time (p. m.).		Pounds.	Time (p. m.).
1	67	3.29	16	58	3.46
2	85	3.33	17	70	3.46½
3	81	3.34	18	94	3.47
4	54	3.37	19	59	3.48
5	53	3.37½	20	45	3.48½
6	92	3.38	21	90	3.49
7	62	3.39	22	70	3.50
8	66	3.40	23	56	3.51
9	69	3.41	24	90	3.52
10	51	3.42	25	45	3.52½
11	63	3.43	26	69	3.53
12	60	3.43½	27	92	3.54
13	79	3.44	28	52	3.54½
14	91	3.45	29	39	3.55
15	62	3.45½			

Remarks.—Test 123: temperature of iron, medium.

MISSOURI NO. 6.

Bituminous coal from a mine 1 mile east of Huntsville, Randolph County, on the Wabash Railroad, was designated Missouri No. 6. The coal, as worked at a depth of 77 feet at this place, averages 3 feet 8 inches in thickness. This sample, shipped under the supervision of John W. Groves, consisted of lump coal over a 6-inch bar screen, and was used in making steaming tests 326 and 327. This sample was also allotted to be used in washing test 155, but the coal was burned in the fire at the plant.

Two mine samples were taken for chemical analysis. Sample 2817 was cut 900 feet north of the shaft, where the coal measured 4 feet in thickness. Sample 2818 was cut 4,000 feet southwest of the shaft, where the coal measured 3 feet 6 inches in thickness.

CHEMICAL ANALYSES.

Missouri No. 6.

	Mine samples.		Car sample.	Steaming tests.[a]	
				326.	327.
Laboratory number	2817	2818	2904		
Air-drying loss	11.80	8.60	11.60		
Proximate:					
Moisture	14.01	11.38	13.80	13.73	12.93
Volatile matter	33.49	37.10	34.29	32.82	34.21
Fixed carbon	42.21	43.07	40.17	39.96	41.63
Ash	10.29	8.45	11.74	13.49	11.23
Sulphur	5.23	3.57	5.60	6.05	5.31
Ultimate:					
Hydrogen			5.48	4.44	4.65
Carbon			58.09	65.24	68.33
Nitrogen			.96	1.08	1.13
Oxygen			18.13	6.59	6.89
Ash				15.64	12.90
Sulphur				7.01	6.10
Calorific value (as received):					
Determined, calories	6,128		5,998		
Determined, B. t. u.	11,030		10,796		
Calculated from ultimate analysis, calories			5,926		
Calculated from ultimate analysis, B. t. u.			0,667		

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Missouri No. 6 (lump).

	Test 326.	Test 327.
Size as used:		
Over 2 inches....per cent..	.....	25.7
2 inches to 1½ inches....do....	.....	27.4
Over 1 inch....do....	36.5	.....
½ inch to 1½ inches....do....	.....	19.2
½ inch to 1 inch....do....	23.3	.....
¼ inch to ½ inch....do....	16.6	12.0
Under ¼ inch....do....	23.6	15.7
Duration of test....hours..	9.92	10.03
Heating value of coal....B. t. u. per pound dry coal..	12,155	12,677
Force of draft:		
Under stack damper....inch water..	0.73	0.75
Above fire....do....	.19	.18
Furnace temperature....°F..	2,476	2,561
Dry coal used per square foot of grate surface per hour....pounds..	21.82	23.06
Equivalent water evaporated per square foot of water-heating surface per hour, pounds....	3.47	3.66
Percentage of rated horsepower of boiler developed....	97.4	102.7
Water apparently evaporated per pound of coal as fired....pounds..	5.71	5.75
Water evaporated from and at 212 °F.:		
Per pound of coal as fired....do....	6.88	6.93
Per pound of dry coal....do....	7.98	7.96
Per pound of combustible....do....	9.64	9.30
Efficiency of boiler, including grate....per cent..	63.40	60.64
Coal as fired:		
Per indicated horsepower hour....pounds..	4.11	4.08
Per electrical horsepower hour....do....	5.08	5.04
Dry coal:		
Per indicated horsepower hour....do....	3.54	3.55
Per electrical horsepower hour....do....	4.38	4.39

MISSOURI NO. 7.

Bituminous coal from a mine one-half mile northwest of Novinger, Adair County, on the Quincy, Omaha and Kansas City Railroad, was designated Missouri No. 7. The coal, as worked at a depth of 88 feet at this place, averages 3 feet in thickness. This sample, shipped under the supervision of W. J. Von Borries, consisted of two lots of coal—No. 1 nut, designated Missouri 7 A, used in steaming tests 329 and 330 and washing test 152, and No. 2 nut, designated Missouri No. 7 B, used in steaming test 332 and washing test 153. This sample was also allotted to be used in washing test 154, but the coal was burned in the fire at the plant.

Two mine samples were taken for chemical analysis. Sample 2823 was cut 1,700 feet northeast of the shaft, where the coal measured 3 feet 3 inches in thickness. Sample 2824 was cut 1,750 feet south of the shaft, where the coal measured 3 feet in thickness.

CHEMICAL ANALYSES.

Missouri No. 7.

	Mine samples.		Car samples.			Steaming tests.[a]		
						A.		B.
			No. 1 nut.	Slack.	No. 2 nut.	329.	330.	332.
Laboratory number	2823	2824	2936	2942	2937	.....	.....	.....
Air-drying loss	14.60	13.70	14.50	15.20	9.70	.....	.....	.....
Proximate:								
Moisture	17.19	16.19	16.36	17.30	16.39	17.26	17.74	17.76
Volatile matter	34.05	31.25	29.12	26.43	29.01	32.11	32.65	32.00
Fixed carbon	39.48	39.87	35.01	32.89	34.42	40.32	39.26	39.95
Ash	9.28	12.69	19.51	23.38	20.18	10.31	10.35	10.29
Sulphur	2.76	3.03	3.53	2.94	3.12	3.27	3.24	3.19
Ultimate:								
Hydrogen	.....	.....	5.23	5.04	5.28	4.70	4.69	4.80
Carbon	.....	.....	49.44	45.41	49.03	68.20	68.11	67.97
Nitrogen	.....	.....	.87	.83	.91	1.20	1.20	1.26
Oxygen	.....	.....	21.42	22.40	21.48	9.49	9.48	9.58
Ash	.....	.....	.....	.....	.....	12.46	12.58	12.51
Sulphur	.....	.....	.....	.....	.....	3.95	3.94	3.88
Calorific value (as received):								
Determined, calories	5,888	.....	5,004	4,578	4,970	.....	.....	.....
Determined, B. t. u.	10,598	.....	9,007	8,240	8,946	.....	.....	.....
Calculated from ultimate analysis, calories	.....	.....	4,953	4,507	4,924	.....	.....	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	8,915	8,113	8,863	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Missouri No. 7 (washed nut).

	A.		B.
	Test 329.	Test 330.	Test 332.
Size as shipped	No. 1	No. 1	No. 2
Size as used:			
Over 1 inch, per cent	47.0	46.3	21.4
½ inch to 1 inch, do	21.6	23.2	43.6
¼ inch to ½ inch, do	14.9	15.0	21.4
Under ¼ inch, do	16.5	15.5	13.6
Duration of test, hours	9.78	5.73	9.75
Heating value of coal, B. t. u. per pound dry coal	12,659	12,643	12,469
Force of draft:			
Under stack damper, inch water	0.60	0.71	0.71
Above fire, do	.14	.13	.....
In ash pit (forced draft), do	.....	.....	.02
Furnace temperature, °F	.....	.....	2,686
Dry coal used per square foot of grate surface per hour, pounds	21.90	25.92	32.03
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.51	4.10	4.62
Percentage of rated horsepower of boiler developed	98.4	115.0	[a]129.4
Water apparently evaporated per pound of coal as fired, pounds	5.53	5.42	4.93
Water evaporated from and at 212 °F.:			
Per pound of coal as fired, do	6.64	6.52	5.94
Per pound of dry coal, do	8.03	7.92	7.22
Per pound of combustible, do	9.32	9.29	8.36
Efficiency of boiler, including grate, per cent	61.26	60.49	55.92
Coal as fired:			
Per indicated horsepower hour, pounds	4.26	4.34	4.76
Per electrical horsepower hour, do	5.26	5.36	5.88
Dry coal:			
Per indicated horsepower hour, do	3.52	3.57	3.92
Per electrical horsepower hour, do	4.35	4.41	4.84

[a] Test made for maximum capacity.

WASHING TESTS.

Missouri No. 7 (nut).

	Test 152 (A).	Test 153 (B).
Size as used	No. 1	No. 2
Jig used	Stewart.	Stewart.
Raw coal, pounds	25,000	23,500
Washed coal, do	21,470	18,600
Refuse, do	3,530	4.900

Analyses.—Test 152: For raw coal analyses see page 171 (sample 2936). Washed coal: Moisture, 17.30; ash, 9.45; sulphur, 3.04. Test 153: For raw coal analyses see page 171 (sample 2937). Washed coal: Moisture, 19.70; ash, 11.05; sulphur, 3.07.

MISSOURI NO. 10.

Bituminous coal from the Bevier bed, at Bevier, Macon County, on the Chicago, Burlington and Quincy Railroad, was designated Missouri No. 10. The coal, as worked at a depth of 124 feet at this place, averages 4 feet 7 inches in thickness.

One sample, shipped under the direction of K. M. Way, consisted of screenings (through a ¾-inch shaking screen) and was used in steaming test 486 (on briquets) and briquetting tests 178†, 179, 241*, 245*, and 246*.

Two mine samples were taken for chemical analysis. Sample 4196 was taken 400 feet south of the shaft, where the coal measured 4 feet 3 inches in thickness. Sample 4197 was taken 2,500 feet west of shaft, where the coal measured 5 feet in thickness.

CHEMICAL ANALYSES.

Missouri No. 10.

	Mine samples.		Car sample.	Steaming test 486.[a]	Briquetting tests.[b]			
					178†.[c]	241*.	245*.	246*.
Laboratory No.	4196	4197	4257	4362	4515	4898	4876	4908
Air-drying loss	8.50	8.80	13.70	1.30	9.40	.....	.....	.....
Proximate:								
Moisture	15.26	15.41	15.23	4.51	11.03	8.91	7.79	7.75
Volatile matter	33.91	32.76	26.32	35.53	32.24	31.81	31.46	32.48
Fixed carbon	42.13	40.22	37.95	41.37	38.67	38.17	39.87	40.95
Ash	8.70	11.61	20.50	18.59	18.06	21.11	20.88	18.82
Sulphur	4.37	3.78	3.69	3.90	3.72	4.49	4.66	4.53
Ultimate:								
Hydrogen	.....	.....	5.02	4.34	.....	4.16	4.12	4.24
Carbon	.....	.....	49.41	64.29	.....	60.16	60.63	62.77
Nitrogen	.....	.....	.84	.91	.....	.84	.84	.91
Oxygen	.....	.....	20.54	6.91	.....	6.73	6.71	6.76
Ash	.....	.....	.....	19.47	.....	23.18	22.65	20.41
Sulphur	.....	.....	.....	4.08	.....	4.93	5.05	4.91
Calorific value determined (calories	.....	5,879	5,055	.....	.....	.....	.....	.....
(as received) B. t. u.	.....	10,582	9,099	.....	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.
[c] No ultimate analysis made.

STEAMING TEST.

Missouri No. 10 (briquets).

	Test 486.
Duration of test.....hours..	9.63
Heating value of fuel.....B. t. u. per pound dry fuel..	11,653
Force of draft:	
Under stack damper.....inch water..	0.79
Above fire.....do....	.15
Dry fuel used per square foot of grate surface per hour.....pounds..	24.69
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	3.28
Percentage of rated horsepower of boiler developed.....	92.0
Water apparently evaporated per pound of fuel as fired.....pounds..	5.25
Water evaporated from and at 212° F.:	
Per pound of fuel as fired.....do....	6.36
Per pound of dry fuel.....do....	6.66
Per pound of combustible.....do....	8.41
Efficiency of boiler, including grate.....per cent..	55.19
Fuel as fired:	
Per indicated horsepower hour.....pounds..	4.45
Per electrical horsepower hour.....do....	5.49
Dry fuel:	
Per indicated horsepower hour.....do....	4.25
Per electrical horsepower hour.....do....	5.24

Remarks.—Test made on briquets from tests 178† and 179. These burned freely, although the rate of combustion decreased as ash formed on the surface, particularly on the English briquets, where the ash could not be separated from the briquets; 2.4 per cent black smoke; ash heavy, gray, and fine; no clinker.

BRIQUETTING TESTS.

Missouri No. 10 (slack).

Tests 178†, 179, 241, 245*, 246*.*—Size as used: Over $\frac{1}{4}$ inch, 3.0 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 10.2 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 17.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 21.2 per cent; through $\frac{1}{40}$ inch, 48.4 per cent. Equally satisfactory briquets were made with 7 and 8 per cent binder on English machine and 8 and 9 per cent on Renfrow machine. The large amount of clay present made briquets soft when warm, but very hard when cold, when fuel was worked with high moisture content. Tests 178† and 179 were made on coal from the same car and under greater pressure than in other tests. These briquets were harder, more cohesive, and made less slack in handling. All the briquets had rough surfaces and broke with ragged fracture. They were of a dull gray color, owing to the amount of clay present. For analyses of briquets see page 172 (those from test 179 under "Steaming test 486").

	Test 178†.	Test 179.	Test 241*.	Test 245*.	Test 246*
Details of manufacture:					
Machine used	Renf.	Eng.	Renf.	Renf.	Eng.
Temperature of briquets.....°F..	176	185	149	149	149
Binder—					
Kind	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4543	4543	4806	4879	4879
Amount.....per cent..	8	7	9	8.5	8
Weight of—					
Fuel briquetted.....pounds..	42,000	5,000	66,000	176,000	10,000
Briquets, average.....do....	0.476	4.43	0.481	0.523	3.91
Heat value per pound—					
Fuel as received.....B. t. u..	9,099	9,099	9,081	9,081	9,081
Fuel as fired.....do....	.....	11,128	10,082	10,262	10,580
Binder.....do....	16,969	16,969	16,864	16,805	16,805
Drop test (1-inch screen):					
Held.....per cent..	80.5	63.3	73.0	58.0	64.4
Passed.....do....	19.5	36.7	27.0	42.0	35.6
Tumbler test (1-inch screen):					
Held.....do....	94.0	90.9	91.5	87.0	64.2
Passed (fines).....do....	6.0	9.1	8.5	13.0	35.8
Fines through 10-mesh sieve.....do....	99.0	80.9	95.0	90.3	50.0

BRIQUETTING TESTS—Continued

Missouri No. 10 (slack).

	Test 178†.	Test 179.	Test 241*.	Test 245*.	Test 246*.
Weathering test:					
Time exposed.....days..	19	19	.....	.....	.....
Condition.....	B.	C.	.....	.....	.....
Water absorption:					
In 19 days.....per cent..	14.5	7.6	.....	.....	.....
In 13 days.....do....	.....	.....	9.0	13.1	6.6
Average for first—					
5 days.....do....	1.94	.....	1.54	2.24	1.12
2 days.....do....	.....	2.2	.....	.....	.....
Specific gravity (apparent).....	1.172	1.238	1.207	1.108	1.248

Extraction analyses.

	Pitches.			Fuel.		Briquets.				
						Test 178†.	Test 179.	Test 241*.	Test 245*.	Test 246*.
Laboratory No.....	4543	4806	4879	4257	4803	4515	4362	4898	4876	4908
Air-drying loss.....per cent..	.....	.....	.....	13.70	10.30	9.40	1.30	.....	.....	.....
Extracted by CS_2:										
Air dried.....do....	.....	.....	.....	.54	.59	8.21	7.64	.....	.....	.....
As received.....do....	99.66	96.90	94.50	.47	.47	7.44	7.54	8.44	8.68	7.63
Pitch in briquets as received, per cent.....	.....	.....	.....	.....	.....	7.03	7.13	8.27	8.73	7.62

MONTANA.

MONTANA NO. 2.

Lignite from the Bridger bed at Fromberg, Carbon County, on the Northern Pacific Railway, was designated Montana No. 2. One sample, shipped under the supervision of N. H. Darton, was used in steaming test 470 and producer-gas test 149. Mine sample 3954 was taken by N. H. Darton.

CHEMICAL ANALYSES.

Montana No. 2.

	Mine sample.	Car sample.	Steaming test 470.[a]		Car sample.	Steaming test 470.[a]
Laboratory No...	3954	4234	.....	Ultimate:		
Air-drying loss....	.....	3.30	.....	Hydrogen.....	4.96	4.31
Proximate:				Carbon.....	58.96	63.36
Moisture.....	8.93	8.51	9.29	Nitrogen.....	1.10	1.18
Volatile matter	33.43	31.58	31.20	Oxygen.....	18.99	12.28
Fixed carbon..	46.92	44.52	42.96	Ash.....	.....	18.24
Ash.....	10.72	15.39	16.55	Sulphur.....	.....	.63
Sulphur.....	.61	.60	.57	Calorific value determined (as received) ..... calories..	5,821	.....
				Calorific value determined (as received) ..... B. t. u...	10,478	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Montana No. 2.

	Test 470.
Size as used:	
Over 1 inch....per cent..	38.2
½ inch to 1 inch....do....	24.1
¼ inch to ½ inch....do....	13.7
Under ¼ inch....do....	24.0
Average diameter....inch..	0.89
Duration of test....hours..	6.50
Heating value of coal....B. t. u. per pound dry coal..	11,257
Force of draft:	
Under stack damper....inch water..	0.88
Above fire....do....	.23
Dry coal used per square foot of grate surface per hour....pounds..	26.51
Equivalent water evaporated per square foot of water-heating surface per hour....do....	4.04
Percentage of rated horsepower of boiler developed	113.30
Water apparently evaporated per pound of coal as fired....pounds..	5.75
Water evaporated from and at 212° F.:	
Per pound of coal as fired....do....	6.93
Per pound of dry coal....do....	7.64
Per pound of combustible....do....	9.71
Efficiency of boiler, including grate....per cent..	65.54
Coal as fired:	
Per indicated horsepower hour....pounds..	4.08
Per electrical horsepower hour....do....	5.04
Dry coal:	
Per indicated horsepower hour....do....	3.70
Per electrical horsepower hour....do....	4.57

PRODUCER-GAS TEST.

Montana No. 2.

Test 149.—Size as used: Over 1 inch, 51 per cent; ½ inch to 1 inch, 21 per cent; ¼ inch to ½ inch, 20 per cent; under ¼ inch, 18 per cent. Duration of test, 40 hours; average electrical horsepower, 188.9; average B. t. u. per cubic foot of gas, 147.5; total coal fired, 15,450 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.13	1.95	1.62
Developed at switch board	2.05	1.87	1.56
Per brake horsepower:			
Commercially available	1.81	1.66	1.38
Developed at engine	1.74	1.59	1.32
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.34	2.14	1.78
Developed at switchboard	2.25	2.06	1.71
Per brake horsepower:			
Commercially available	1.99	1.82	1.52
Developed at engine	1.91	1.75	1.45

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	13.2
Carbon monoxide (CO)	14.2
Hydrogen (H_2)	16.0
Methane (CH_4)	2.9
Nitrogen (N_2)	25.9
Oxygen (O_2)	.2
Ethylene (C_2H_4)	.6

[a] For analysis of fuel used see page 174 (sample 4234).

MONTANA NO. 3.

Lignite from the Bridger bed at Bridger, Carbon County, on the Northern Pacific Railway, was designated Montana No. 3. One sample, shipped under the supervision of N. H. Darton, was used in steaming test 477 and producer-gas test 150. Two mine samples, 3955 and 3956, were taken by N. H. Darton.

CHEMICAL ANALYSES.

Montana No. 3.

	Mine samples.		Car sample.	Steaming test 477.[a]
Laboratory No.	3955	3956	4271	.....
Air-drying loss	.....	.....	3.10	.....
Proximate:				
Moisture	8.47	8.70	8.56	9.2
Volatile matter	31.47	34.03	32.36	32.22
Fixed carbon	41.88	49.07	45.69	44.93
Ash	18.18	8.20	13.39	13.63
Sulphur	.84	.63	.54	.60
Ultimate:				
Hydrogen	.....	.....	5.06	4.47
Carbon	.....	.....	60.39	65.70
Nitrogen	.....	.....	1.06	1.16
Oxygen	.....	.....	19.56	13.00
Ash	.....	.....	.....	15.01
Sulphur	.....	.....	.....	.66
Calorific value determined (as received) calories	.....	.....	5,936	.....
Calorific value determined (as received) B. t. u.	.....	.....	10,685	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Montana No. 3.

	Test 477.
Size as used:	
Over 1 inch, per cent	52.9
½ inch to 1 inch, do	21.6
¼ inch to ½ inch, do	10.9
Under ¼ inch, do	14.6
Average diameter, inches	1.46
Duration of test, hours	8.97
Heating value of coal, B. t. u. per pound dry coal	11,628
Force of draft:	
Under stack damper, inch water	0.86
Above fire, do	.14
Dry coal used per square foot of grate surface per hour, pounds	26.98
Equivalent water evaporated per square foot of water-heating surface per hour, do	4.11
Percentage of rated horsepower of boiler developed	115.2
Water apparently evaporated per pound of coal as fired, pounds	5.75
Water evaporated from and at 212° F.:	
Per pound of coal as fired, do	6.92
Per pound of dry coal, do	7.63
Per pound of combustible, do	9.32
Efficiency of boiler, including grate, per cent	63.37
Coal as fired:	
Per indicated horsepower hour, pounds	4.09
Per electrical horsepower hour, do	5.04
Dry coal:	
Per indicated horsepower hour, do	3.71
Per electrical horsepower hour, do	4.58

PRODUCER-GAS TEST.

Montana No. 3.

Test 150.—Duration of test, 49 hours. Average electrical horsepower, 199.6; average B. t. u. per cubic foot of gas, 181.5; total coal fired, 15,950 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.69	1.55	1.32
Developed at switch board	1.63	1.49	1.27
Per brake horsepower:			
Commercially available	1.44	1.31	1.12
Developed at engine	1.39	1.27	1.08
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.80	1.65	1.41
Developed at switch board	1.74	1.59	1.36
Per brake horsepower:			
Commercially available	1.53	1.40	1.20
Developed at engine	1.48	1.35	1.15

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	8.0
Carbon monoxide (CO)	23.2
Hydrogen (H_2)	15.9
Methane (CH_4)	3.3
Nitrogen (N_2)	49.2
Ethylene (C_2H_4)	.4

NEW MEXICO.

NEW MEXICO NO. 3.

Bituminous coal from Van Houten, Colfax County, on the Atchison, Topeka and Santa Fe Railway, was designated New Mexico No. 3. The coal, as worked from an outcrop at this place, averages 6 feet 6 inches in thickness.

Three kinds of coal were shipped from this mine under the supervision of J. S. Burrows: New Mexico No. 3 A consisted of run-of-mine coal used in steaming test 396 and producer-gas test 121. New Mexico No. 3 B consisted of 10 tons of lump and was used in steaming tests 389 and 391; also, together with equal portions of washed New Mexico No. 4 B and No. 5, in coking test 152 and cupola tests 98 and 130. New Mexico No. 3 C consisted of 40 tons of slack, and was used in steaming test 392 (on washed coal); washing test 168; and coking tests 148 and 149 (on washed coal). At this mine coal that passes through a $\frac{3}{4}$-inch screen is called "slack," and that passing over the $\frac{3}{4}$-inch screen is graded as "lump."

Two mine samples taken for chemical analysis. Sample 3221 was taken 2,000 feet northwest of the drift mouth, where the coal measured 6 feet 11 inches in thickness. Sample 3222 was taken 3,000 feet from the drift mouth, where the coal measured 6 feet 11 inches in thickness.

[a] For analysis of fuel used, see page 176 (sample 4271).

CHEMICAL ANALYSES.

New Mexico No. 3.

	Mine samples.		Car samples.			Steaming tests.[a]			
						A.	B.		C.
			A.	C.	B.	396.	389.	391.	392.
Laboratory No.	3221	3222	3295	3307	3308	.....	.....	.....	.....
Air-drying loss	1.00	2.00	2.00	3.00	1.40	.....	.....	.....	.....
Proximate:									
Moisture	2.50	3.48	3.45	4.36	2.75	2.82	3.01	2.47	4.77
Volatile matter	35.47	33.02	32.00	32.21	33.19	32.72	32.61	32.99	33.10
Fixed carbon	52.90	50.58	47.82	47.51	48.54	47.56	47.05	47.63	49.90
Ash	9.13	12.92	16.67	15.92	15.52	16.90	17.33	16.91	12.23
Sulphur	.72	.64	.73	.83	.64	.72	.72	.67	.71
Ultimate:									
Hydrogen	.....	.....	4.95	4.79	4.84	4.72	4.55	4.58	4.83
Carbon	.....	.....	66.19	65.96	67.70	68.45	67.93	68.43	72.14
Nitrogen	.....	.....	1.23	1.18	1.18	1.28	1.19	1.19	1.26
Oxygen	.....	.....	10.23	11.32	10.12	7.42	7.72	7.77	8.17
Ash	.....	.....	.....	.....	.....	17.39	17.87	17.34	12.85
Sulphur	.....	.....	.....	.....	.....	.74	.74	.69	.75
Calorific value (as received):									
Determined—calories	7,293	.....	6,607	6,618	6,759	.....	.....	.....	.....
Determined—B. t. u.	13,127	.....	11,893	11,912	12,166	.....	.....	.....	.....
Calculated from ultimate analysis—calories	.....	.....	6,629	6,509	6,715	.....	.....	.....	.....
Calculated from ultimate analysis—B. t. u.	.....	.....	11,932	11,716	12,087	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

New Mexico No. 3.

	A.	B.		C.
	Test 396.	Test 389.	Test 391.	Test 392 (w.).
Size as shipped	r. o. m.	l.	l.	s.
Size as used:				
Over 1 inch—per cent.	14.8	30.6	34.5	5.6
½ inch to 1 inch—do.	23.2	27.1	27.9	27.9
¼ inch to ½ inch—do.	22.2	18.3	16.8	31.3
Under ¼ inch—do.	39.8	24.0	20.8	35.2
Duration of test—hours.	10.0	10.0	10.0	9.37
Heating value of coal—B. t. u. per pound dry coal.	12,301	12,213	12,301	13,059
Force of draft:				
Under stack damper—inch water.	0.60	0.54	0.57	0.64
Above fire—do.	.22	.18	.21	.22
Furnace temperature—°F.	2,333	2,225	2,432	2,420
Dry coal used per square foot of grate surface per hour, pounds	23.48	20.91	23.82	24.56
Equivalent water evaporated per square foot of water-heat-surface per hour—pounds.	3.86	3.51	4.09	4.25
Percentage of rated horsepower of boiler developed	108.2	98.5	114.8	119.2
Water apparently evaporated per pound of coal as fired, pounds	6.84	7.02	7.18	7.08
Water evaporated from and at 212 °F.:				
Per pound of coal as fired—pounds.	8.00	8.16	8.40	8.26
Per pound of dry coal—do.	8.23	8.42	8.61	8.68
Per pound of combustible—do.	10.36	10.54	10.66	10.16
Efficiency of boiler, including grate—per cent.	64.61	66.58	67.59	64.19
Coal as fired:				
Per indicated horsepower hour—pounds.	3.54	3.46	3.37	3.42
Per electrical horsepower hour—do.	4.36	4.28	4.16	4.23
Dry coal:				
Per indicated horsepower hour—do.	3.44	3.36	3.28	3.26
Per electrical horsepower hour—do.	4.24	4.15	4.06	4.02

PRODUCER-GAS TEST.

New Mexico No. 3 A (run of mine).

Test 121.—Duration of test, 50 hours; average electrical horsepower, 198.4; average B. t. u. per cubic foot of gas, 155.1; total coal fired, 12,850 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.37	1.32	1.05
Developed at switch board	1.30	1.25	.99
Per brake horsepower:			
Commercially available	1.17	1.12	.90
Developed at engine	1.10	1.06	.85
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.47	1.42	1.13
Developed at switch board	1.39	1.34	1.07
Per brake horsepower:			
Commercially available	1.25	1.21	.96
Developed at engine	1.18	1.14	.91

Analyses.

Coal.		*Gas by volume.*	
Moisture	3.62	Carbon dioxide (CO_2)	9.2
Volatile matter	31.56	Carbon monoxide (CO)	20.5
Fixed carbon	45.19	Hydrogen (H_2)	14.5
Ash	19.63	Methane (CH_4)	2.0
Sulphur	.72	Nitrogen (N_2)	53.4
		Ethylene (C_2H_4)	.4

WASHING AND COKING TESTS.

New Mexico No. 3.

Washing test 168 (coal C, slack).—Jig used, Stewart. Raw coal, 43,000 pounds; washed coal, 38,000 pounds; refuse 5,000 pounds.

Coking tests.

		3 C (s.).		3 B (l.), 4 B (s.), and 5 (r. o. m.).
		Test 148 (raw).	Test 149 (w.).	Test 152 (w.).
Size as used		f. c.	f. c.	f. c.
Duration of test	hours.	52	48	48
Coal charged	pounds.	12,120	11,710	12,000
Coke produced	do.	7,655	7,233	7,596
	per cent.	63.16	61.77	63.30
Breeze produced	pounds.	410	360	328
	per cent.	3.38	3.07	2.73
Total yield	do.	66.54	64.84	66.03

Remarks.—Test 148: Light gray and silvery; good heavy coke; ash high. Test 149: Light gray and silvery; good heavy coke; ash reduced by washing, but still high. Test 152: Light gray and silvery; good, strong, heavy coke; good ring, breakage, and cell structure.

Analyses.

	Washing test 168.		Coking test 148.		Coking test 149.		Coking test 152.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	4.36	6.01	3.68	0.76	5.74	0.88	5.13	0.69
Volatile matter	32.21	.....	33.06	.67	33.02	1.51	33.88	1.48
Fixed carbon	47.51	.....	48.94	78.14	48.99	80.42	50.06	82.18
Ash	15.92	12.43	14.32	20.43	12.25	17.19	10.93	15.65
Sulphur	.83	.71	.78	.71	.72	.65	.69	.63

Cupola tests of coke made from New Mexico Nos. 3 B, 4 B, and 5 coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
98	152	1.91	7	99.9	Coke	210	55	55	55	55	430
					Pig iron	630	405	405	405	405	2,250
					Scrap	210	135	135	135	135	750
130	152	1.91	7	99.9	Coke	200	58	58	57	57	430
					Pig iron	600	413	413	412	412	2,250
					Scrap	200	138	138	137	137	750

[a] Phosphorus in coke, 0.0348 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Maximum.	Iron running in—	Weight of iron. Poured.	Additional melted.	Total.	Melting. Time.	Rate per hour.	Ratio iron to coke.	Loss.	Recovered. Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
98	1.48 p. m.	7	11	1,162	325	1,487	29	3,076	4.31	7.50	1,288	85
130	3.18 p. m.	7	10	1,778	252	2,030	28	4,511	6.51	7.03	759	118

LADLE RECORD.

Ladle No.	Test 98. Pounds.	Time (p. m.).	Test 130. Pounds.	Time (p. m.).	Ladle No.	Test 98. Pounds.	Time (p. m.).	Test 130. Pounds.	Time (p. m.).
1	83	2.07	94	3.34	13	55	2.24	94	3.45
2	86	2.07½	52	3.34½	14	64	2.24½	84	3.45½
3	39	2.08	97	3.38	15	53	2.25	82	3.46
4	78	2.15	88	3.38½	16	68	2.27	24	3.47
5	79	2.15½	79	3.39	17	42	2.27½	86	3.49½
6	86	2.16	109	3.39½	18	66	2.28	99	3.50
7	58	2.18	83	3.40½	19	.....	.....	84	3.51
8	66	2.18½	82	3.41	20	.....	.....	64	3.51½
9	70	2.19	91	3.42	21	.....	.....	86	3.53½
10	52	2.21	95	3.42½	22	.....	.....	25	3.54
11	61	2.22	75	3.43½	23	.....	.....	57	3.55
12	56	2.22½	48	3.44					

Remarks.—Test 98: Iron very hot and fluid. Large quantities of slag closed up tuyeres after sixteenth ladle.

NEW MEXICO NO. 4.

Bituminous coal from Brilliant, Colfax County, on the Atchison, Topeka and Santa Fe Railway, was designated New Mexico No. 4. The coal, as worked from the outcrop at this place, averages 5 feet in thickness.

Two samples of coal were taken from these mines for testing purposes under the supervision of J. S. Burrows. New Mexico No. 4 A consisted of run-of-mine coal and was used in making steaming tests 397 (raw) and 398 (washed), producer-gas test 122, and washing test 174. New Mexico No. 4 B consisted of slack coal through a 1¼-inch perforated screen, and was used in making steaming test 395, washing test 170, coking tests 150 (raw) and 151 (washed), and cupola test 119. Mixed with New Mexico No. 3 B and No. 5 (equal portions, washed), No. 4 B was also used in coking test 152 (see p. 179) and cupola tests 98 and 130 (see p. 180).

Two mine samples were taken for chemical analysis. Sample 3228 was taken 475 feet southwest of the drift mouth, where the coal measured 5 feet 8 inches in thickness. Sample 3229 was taken 800 feet south of the drift mouth, where the coal measured 4 feet 3 inches in thickness.

CHEMICAL ANALYSES.

New Mexico No. 4.

	Mine samples.		Car samples.		Steaming tests.[a]		
			A.	B.	A.		B.
					397.	398.	395.
Laboratory No	3228	3229	3331	3315			
Air-drying loss	1.00	1.30	1.40	1.70			
Proximate:							
Moisture	2.19	2.67	2.78	3.38	2.30	3.86	3.37
Volatile matter	35.95	36.25	34.31	34.63	34.59	34.06	34.70
Fixed carbon	50.75	51.26	48.34	48.45	48.53	50.68	48.18
Ash	11.11	9.82	14.57	13.54	14.58	11.40	13.75
Sulphur	.57	.58	.61	.61	.60	.63	.62
Ultimate:							
Hydrogen			5.06	5.13	4.89	5.07	4.91
Carbon			68.51	68.67	70.54	73.07	70.90
Nitrogen			1.51	1.50	1.56	1.61	1.55
Oxygen			9.74	10.55	7.48	7.73	7.77
Ash					.61	.66	.64
Sulphur					14.92	11.86	14.23
Calorific values (as received):							
Determined: calories	7,257		6,830	6,914			
Determined: B. t. u.	13,063		12,294	12,445			
Calculated from ultimate analysis: calories			6,873	6,875			
Calculated from ultimate analysis: B. t. u.			12,371	12,375			

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

New Mexico No. 4.

	A.		B.
	Test 397.	Test 398 (w.).	Test 395.
Size as shipped	r. o. m.	r. o. m.	s.
Size as used:			
Over 1 inch, per cent	21.3	17.4	1.7
½ inch to 1 inch, do	23.2	21.6	17.8
¼ inch to ½ inch, do	18.8	25.2	27.4
Under ¼ inch, do	36.7	35.8	53.1
Duration of test, hours	10.0	10.07	10.08
Heating value of coal, B. t. u. per pound dry coal	12,659	13,149	12,847
Force of draft:			
Under stack damper, inch water	0.64	0.64	0.61
Above fire, do	.25	.25	.22
Furnace temperature, ° F.	2,336	2,534	2,285
Dry coal used per square foot of grate surface per hour, pounds	22.76	21.92	21.33
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.71	3.86	3.59
Percentage of rated horsepower of boiler developed	103.9	108.1	100.6
Water apparently evaporated per pound of coal as fired, pounds	6.79	7.23	6.96
Water evaporated from and at 212° F.:			
Per pound of coal as fired, do	7.97	8.47	8.14
Per pound of dry coal, do	8.16	8.81	8.43
Per pound of combustible, do	9.84	10.17	10.10
Efficiency of boiler, including grate, per cent	62.25	64.70	63.37
Coal as fired:			
Per indicated horsepower hour, pounds	3.55	3.34	3.47
Per electrical horsepower hour, do	4.38	4.12	4.29
Dry coal:			
Per indicated horsepower hour, do	3.47	3.21	3.35
Per electrical horsepower hour, do	4.28	3.96	4.14

PRODUCER-GAS TEST.

New Mexico No. 4 A (run of mine).

Test 122.—Duration of test, 50 hours. Average electrical horsepower, 189.5. Average B. t. u. per cubic foot of gas, 135.3. Total coal fired, 13,110 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.48	1.44	1.24
Developed at switchboard	1.38	1.35	1.16
Per brake horsepower:			
Commercially available	1.25	1.22	1.05
Developed at engine	1.18	1.15	0.99
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.62	1.58	1.36
Developed at switchboard	1.52	1.48	1.28
Per brake horsepower:			
Commercially available	1.38	1.34	1.16
Developed at engine	1.29	1.26	1.08

Analyses.

Coal.		*Gas by volume.*	
Moisture	2.42	Carbon dioxide (CO_2)	10.6
Volatile matter	34.82	Carbon monoxide (CO)	17.0
Fixed carbon	49.23	Hydrogen (H_2)	12.6
Ash	13.53	Methane (CH_4)	2.0
Sulphur	.63	Nitrogen (N_2)	57.2
		Ethylene (C_2H_4)	.6

WASHING AND COKING TESTS.

New Mexico No. 4.

Washing tests.

	Test 174 (A).	Test 170 (B).
Size as shipped	r. o. m.	s.
As used	cr. to 2"	s.
Jig used	Stewart.	Stewart.
Raw coal, pounds	20,000	24,000
Washed coal, do	16,275	21,000
Refuse, do	3,725	3,000

Coking tests (B).

	Test 150 (raw).	Test 151 (w.).
Size as used	f. c.	f. c.
Duration of test, hours	49	43
Coal charged, pounds	11,790	11,430
Coke produced, do	7,610	6,986
Coke produced, per cent	64.55	61.12
Breeze produced, pounds	362	307
Breeze produced, per cent	3.07	2.69
Total yield, do	67.62	63.81

Remarks.—Test 150: Light gray and silvery; good heavy coke; ash high. Test 151: Light gray and silvery; good heavy coke; ash reduced by washing.

Analyses.

	Washing test 174 (A).		Washing test 170 (B).		Coking test 150 (B).		Coking test 151 (B).	
	Raw.	Washed.	Raw.	Washed.	Coal.	Coke.	Coal.	Coke.
Moisture	2.78	3.71	3.38	5.97	3.69	1.10	5.52	1.39
Volatile matter	34.31	.....	34.63	.....	34.62	.94	35.29	.85
Fixed carbon	48.34	.....	48.45	.....	47.83	78.48	49.87	83.66
Ash	14.57	11.39	13.54	9.41	13.86	19.48	9.32	14.10
Sulphur	.61	.58	.61	.65	.66	.58	.67	.60

Cupola test of coke made from New Mexico No. 4 B coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Coke.[a] Specific gravity.	Coke.[a] Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
119	151	1.92	7	98.61	Coke	200	58	58	57	57	430
					Pig iron	600	413	413	412	412	2,250
					Scrap	200	138	138	137	137	750

[a] Phosphorus in coke, 0.0946 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
119	8.57 a. m.	7	6	2,210	351	2,561	31	4,957	7.30	9.23	162	79

Cupola test of coke made from New Mexico No. 4 B coal (washed)—Continued.

LADLE RECORD.

Ladle No.	Test 119. Pounds.	Test 119. Time (a. m.).	Ladle No.	Test 119. Pounds.	Test 119. Time (a. m.).
1	95	9.12	14	83	9.25
2	53	9.12½	15	76	9.26
3	96	9.16	16	103	9.26½
4	94	9.16½	17	81	9.27
5	28	9.17	18	88	9.28
6	88	9.19	19	106	9.28½
7	102	9.20	20	86	9.29
8	70	9.20½	21	70	9.29½
9	89	9.21	22	101	9.31
10	66	9.23	23	82	9.32
11	86	9.23½	24	65	9.32½
12	85	9.24	25	69	9.33
13	106	9.24½	26	142	9.34

NEW MEXICO NO. 5.

Bituminous coal from Blossburg, Colfax County, on the Atchison, Topeka and Santa Fe Railway, was designated New Mexico No. 5. The coal, as worked from the outcrop at this place, averages 7 feet 6 inches in thickness.

This sample was run-of-mine coal loaded under the supervision of J. S. Burrows, and was used in making steaming test 387, producer-gas test 120, washing test 167, coking tests 146 (raw) and 147 (washed), and cupola test 120. Mixed with New Mexico No. 3 B and No. 4 B (equal portions, washed), it was also used in coking test 152 (see p. 179) and cupola tests 98 and 130 (see p. 180).

Two mine samples were taken for chemical analysis. Sample 3226 was taken 5,300 feet north of the slope, where the coal measured 7 feet in thickness. Sample 3227 was taken 4,200 feet southwest of the slope, where the coal measured 7 feet 8 inches in thickness.

CHEMICAL ANALYSES.

New Mexico No. 5.

	Mine samples.		Car sample.	Steaming test 387.[a]
Laboratory No	3226	3227	3294	.....
Air-drying loss	1.20	1.20	1.40	.....
Proximate:				
Moisture	2.25	2.31	2.72	2.32
Volatile matter	33.19	33.01	31.85	31.80
Fixed carbon	52.19	51.58	50.86	50.23
Ash	12.37	13.10	14.57	15.65
Sulphur	.75	.66	.69	.79
Ultimate:				
Hydrogen	.....	.....	4.88	4.65
Carbon	.....	.....	69.96	70.94
Nitrogen	.....	.....	1.17	1.19
Oxygen	.....	.....	8.73	6.39
Ash	.....	.....	.....	16.02
Sulphur	.....	.....	.....	.81
Calorific value (as received):				
Determined, calories	7,239	.....	6,966	.....
Determined, B. t. u.	13,030	.....	12,539	.....
Calculated from ultimate analysis, calories	.....	.....	6,974	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	12,553	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

New Mexico No. 5 (run of mine).

	Test 387.
Size as used:	
Over 1 inch ..... per cent	21.2
½ inch to 1 inch ..... do	19.9
¼ to ½ inch ..... do	20.8
Under ¼ inch ..... do	38.1
Duration of test ..... hours	10.07
Heating value of coal ..... B. t. u. per pound dry coal	12,721
Force of draft:	
Under stack damper ..... inch water	0.58
Above fire ..... do	.21
Furnace temperature ..... °F	2,371
Dry coal used per square foot of grate surface per hour ..... pounds	21.11
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	3.54
Percentage of rated horsepower of boiler developed	99.13
Water apparently evaporated per pound of coal as fired ..... pounds	7.0
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... do	8.19
Per pound of dry coal ..... do	8.39
Per pound of combustible ..... do	10.23
Efficiency of boiler, including grate ..... per cent	63.69
Coal as fired:	
Per indicated horsepower hour ..... pounds	3.45
Per electrical horsepower hour ..... do	4.26
Dry coal:	
Per indicated horsepower hour ..... do	3.37
Per electrical horsepower hour ..... do	4.16

PRODUCER-GAS TEST.

New Mexico No. 5 (run of mine).

Test 120.—Duration of test, 45 hours. Average electrical horsepower, 197.2. Average B. t. u. per cubic foot of gas, 159.6. Total coal fired, 12,500 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.49	1.47	1.24
Developed at switchboard	1.41	1.38	1.17
Per brake horsepower:			
Commercially available	1.27	1.25	1.05
Developed at engine	1.20	1.18	0.99
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.60	1.57	1.33
Developed at switchboard	1.51	1.48	1.25
Per brake horsepower:			
Commercially available	1.36	1.34	1.13
Developed at engine	1.29	1.26	1.06

Analyses:

Coal.		*Gas by volume.*	
Moisture	1.79	Carbon dioxide (CO_2)	8.6
Volatile matter	31.32	Carbon monoxide (CO)	21.4
Fixed carbon	51.40	Hydrogen (H_2)	14.6
Ash	15.49	Methane (CH_4)	2.2
Sulphur	.66	Nitrogen (H_2)	52.7
		Ethylene (C_2H_4)	.5

WASHING AND COKING TESTS.

New Mexico No. 5 (run of mine).

Washing test 167.—Size as used, crushed to 2 inches; jig used, Stewart; raw coal, 15,000 pounds; washed coal, 13,300 pounds; refuse, 1,700 pounds.

Coking tests.

	Test 146 (raw)	Test 147 (w.)
Size as used	f. c.	f. c.
Duration of test, hours	56	50
Coal charged, pounds	11,810	11,770
Coke produced, do	7,500	7,650
Coke produced, per cent	63.51	65.00
Breeze produced, pounds	320	280
Breeze produced, per cent	2.71	2.38
Total yield, do	66.22	67.38

Remarks.—Test 146: Light gray color; good heavy coke; high ash. Test 147: Light gray and silvery; good heavy coke; ash reduced by washing, but still high.

Analyses.

	Washing test 167.		Coking test 146.		Coking test 147.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	2.72	4.68	3.05	1.04	4.23	0.99
Volatile matter	31.85	.....	31.96	1.44	32.25	.84
Fixed carbon	50.86	.....	49.71	76.93	51.79	81.38
Ash	14.57	11.87	15.28	20.59	11.73	16.79
Sulphur	.69	.91	.76	.86	.89	.76

Cupola test of coke made from New Mexico No. 5 coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Coke.[a] Specific gravity.	Coke.[a] Ratio, iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
120	147	1.91	7	99.9	Coke	220	53	53	52	52	430
					Pig iron	660	398	398	397	397	2,250
					Scrap	220	133	133	132	132	750

[a] Phosphorus in coke, 0.001 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
120	2.17 p. m.	7	10	1,354	124	1,478	28	3,167	4.58	7.40	1,300	107

Cupola test of coke made from New Mexico No. 5 coal (washed)—Continued.

LADLE RECORD.

Ladle No.	Test 120.		Ladle No.	Test 120.	
	Pounds.	Time (p. m.).		Pounds.	Time (p. m.).
1	93	2.34	10	99	2.43½
2	50	2.34½	11	96	2.44½
3	57	2.39	12	101	2.47
4	107	2.39½	13	90	2.48
5	99	2.40	14	56	2.47
6	43	2.40½	15	92	2.52½
7	83	2.41	16	32	2.53
8	92	2.42	17	69	2.55
9	95	2.43			

Remarks.—Test 120: Iron hot and fluid.

OHIO.

OHIO NO. 10.

Bituminous coal from bed No. 5, at Mineral City, Tuscarawas County, was designated Ohio No. 10. The coal, as worked from the outcrop at this place, averages 3 feet 5 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of lump coal over a 1¼-inch bar screen, and was used in steaming test 469 and producer-gas test 142.

Two mine samples were taken for chemical analysis. Sample 3968 was taken 7,000 feet southeast of the opening, where the coal measured 3 feet 3 inches in thickness. Sample 3969 was taken 6,600 feet southeast of the opening, where the coal measured 3 feet 7 inches in thickness.

CHEMICAL ANALYSES.

Ohio No. 10.

	Mine samples.		Car sample.	Steaming test 469.[a]
Laboratory No.	3968	3969	4059	.....
Air-drying loss	1.30	1.10	2.30	.....
Proximate:				
Moisture	5.61	4.46	4.49	4.10
Volatile matter	36.25	39.89	40.55	39.55
Fixed carbon	49.42	47.11	47.43	47.54
Ash	8.72	8.54	7.53	8.81
Sulphur	2.89	3.73	2.93	3.60
Ultimate:				
Hydrogen	.....	.....	5.68	5.30
Carbon	.....	.....	69.64	71.28
Nitrogen	.....	.....	1.29	1.32
Oxygen	.....	.....	12.93	9.15
Ash	.....	.....	.....	9.19
Sulphur	.....	.....	.....	3.76
Calorific value determined (as received) calories	.....	7,136	7,199	.....
Calorific value determined (as received) B. t. u.	.....	12,845	12,958	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Ohio No. 10.

	Test 469.
Size as used:	
Over 1 inch.....per cent..	58.3
½ inch to 1 inch.....do....	13.9
¼ inch to ½ inch.....do....	9.1
Under ¼ inch.....do....	18.7
Average diameter.....inches..	1.30
Duration of test.....hours..	10.02
Heating value of coal.....B. t. u. per pound dry coal..	13,291
Force of draft:	
Under stack damper.....inch water..	0.81
Above fire.....do....	.19
Furnace temperature.....°F..	2,877
Dry coal used per square foot of grate surface per hour.....pounds..	22.91
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	4.25
Percentage of rated horsepower of boiler developed.....	119.1
Water apparently evaporated per pound of coal as fired.....pounds..	7.38
Water evaporated from and at 212° F.:	
Per pound of coal as fired.....do....	8.90
Per pound of dry coal.....do....	9.28
Per pound of combustible.....do....	10.39
Efficiency of boiler, including grate.....per cent..	67.43
Coal as fired:	
Per indicated horsepower hour.....pounds..	3.18
Per electrical horsepower hour.....do....	3.92
Dry coal:	
Per indicated horsepower hour.....do....	3.05
Per electrical horsepower hour.....do....	3.76

PRODUCER-GAS TEST.

Ohio No. 10 (lump).

Test 142.—Size as used: Over 1 inch, 64 per cent; ½ inch to 1 inch, 17 per cent; ¼ inch to ½ inch, 8 per cent; under ¼ inch, 11 per cent. Duration of test, 50 hours. Average electrical horsepower, 199.0. Average B. t. u. per cubic foot of gas, 165.6. Total coal fired, 12,650 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.32	1.27	1.15
Developed at switch board	1.27	1.22	1.11
Per brake horsepower:			
Commercially available	1.12	1.08	.98
Developed at engine	1.08	1.04	.94
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.40	1.35	1.22
Developed at switch board	1.35	1.30	1.18
Per brake horsepower:			
Commercially available	1.19	1.15	1.04
Developed at engine	1.15	1.10	1.00

Analyses.

Coal.		*Gas by volume.*	
Moisture	4.05	Carbon dioxide (CO_2)	9.4
Volatile matter	39.28	Carbon monoxide (CO)	20.7
Fixed carbon	47.75	Hydrogen (H_2)	14.2
Ash	8.92	Methane (CH_4)	2.6
Sulphur	3.02	Nitrogen (N_2)	52.6
		Ethylene (C_2H_4)	.5

OHIO NO. 11.

Bituminous coal from bed No. 8 at Flushing, Belmont County, on the Baltimore and Ohio Railroad, was designated Ohio No. 11. The coal, as worked at a depth of 89 feet at this place, averages 4 feet 10 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of lump coal over a 1¼-inch screen and was used in steaming tests 474 and 475 and producer-gas test 145.

Two mine samples were taken for chemical analysis. Sample 3985 was taken 2,000 feet west of the shaft, where the coal measured 4 feet 8¼ inches in thickness. Sample 3986 was taken 1,500 feet southwest of the shaft, where the coal measured 5 feet 1 inch in thickness.

CHEMICAL ANALYSES.

Ohio No. 11.

	Mine samples.		Car sample.	Steaming tests.[a]	
				474.	475.
Laboratory No	3985	3986	4157	.....	.....
Air-drying loss	1.70	1.90	1.60	.....	.....
Proximate:					
Moisture	3.96	4.13	3.44	3.56	3.53
Volatile matter	38.09	39.22	36.04	37.86	37.33
Fixed carbon	48.91	48.69	47.58	47.91	47.92
Ash	9.04	7.96	12.94	10.67	11.22
Sulphur	4.25	4.12	4.32	4.03	5.24
Ultimate:					
Hydrogen	.....	.....	4.81	4.74	4.63
Carbon	.....	.....	66.64	71.23	69.70
Nitrogen	.....	.....	1.17	1.25	1.22
Oxygen	.....	.....	10.12	7.54	7.39
Ash	.....	.....	.....	11.06	11.63
Sulphur	.....	.....	.....	4.18	5.43
Calorific value determined (as received) calories	.....	7,271	6,826	.....	.....
Calorific value determined (as received) B. t. u.	.....	13,088	12,287	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Ohio No. 11.

	Test 474.	Test 475.
Size as used:		
Over 1 inch, per cent	65.7	71.7
½ inch to 1 inch, do	16.8	12.9
¼ inch to ½ inch, do	7.6	6.7
Under ¼ inch, do	9.9	8.7
Average diameter, inches	1.72	2.06
Duration of test, hours	9.23	9.28
Heating value of coal, B. t. u. per pound dry coal	13,115	12,890
Force of draft:		
Under stack damper, inch water	0.78	0.77
Above fire, do	.20	.19
Furnace temperature, °F.	2,748	2,893
Dry coal used per square foot of grate surface per hour, pounds	20.84	20.67
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.65	3.66
Percentage of rated horsepower of boiler developed	102.4	102.5
Water apparently evaporated per pound of coal as fired, pounds	7.04	7.08
Water evaporated from and at 212° F.:		
Per pound of coal as fired, do	8.47	8.55
Per pound of dry coal, do	8.79	8.86
Per pound of combustible, do	10.14	10.21
Efficiency of boiler, including grate, per cent	64.72	66.38

STEAMING TESTS—Continued.

Ohio No. 11.

	Test 474.	Test 475.
Coal as fired:		
Per indicated horsepower hour.....pounds..	3.34	3.31
Per electrical horsepower hour.....do....	4.12	4.08
Dry coal:		
Per indicated horsepower hour.....do....	3.22	3.19
Per electrical horsepower hour.....do....	3.97	3.94

PRODUCER-GAS TEST.

Ohio No. 11 (lump).

Test 145.—Size as used, over 1 inch, 66 per cent.; ½ inch to 1 inch, 14 per cent.; ¼ inch to ½ inch, 7 per cent. Under ¼ inch, 13 per cent. Duration of test, 50 hours. Average electrical horsepower, 199.5. Average B. t. u. per cubic foot of gas, 165.200. Total coal fired, 13,850 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.45	1.40	1.21
Developed at switchboard	1.39	1.34	1.16
Per brake horsepower:			
Commercially available	1.23	1.19	1.03
Developed at engine	1.18	1.14	.99
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.55	1.50	1.30
Developed at switchboard	1.49	1.44	1.24
Per brake horsepower:			
Commercially available	1.32	1.27	1.10
Developed at engine	1.26	1.22	1.06

Analysis of gas by volume. [a]

Carbon dioxide (CO_2)	9.0
Carbon monoxide (CO)	20.2
Hydrogen (H_2)	15.3
Methane (CH_4)	2.7
Nitrogen (N_2)	52.3
Ethylene (C_2H_4)	0.5

OHIO NO. 12.

Bituminous coal from bed No. 8, at Bellaire, Belmont County, was designated Ohio No. 12. The coal, as worked from the outcrop at this place, averages 5 feet 5 inches in thickness.

One sample, shipped under the supervision of K. M. Way, consisted of run-of-mine coal and was used in steaming test 483, producer-gas tests 146 and 147, washing test 193, and coking test 180.

Two mine samples were taken for chemical analysis. Sample 3987 was taken at a face where the coal measured 5 feet 6¼ inches in thickness. Sample 3988 was taken at a face where the coal measured 5 feet 4½ inches in thickness.

[a] For analysis of fuel used see page 189 (sample 4157).

CHEMICAL ANALYSES.

Ohio No. 12.

	Mine samples.		Car samples.		Steaming test 483.[a]
Laboratory No	3987	3988	4151	4178	.....
Air-drying loss	1.20	1.10	2.60	1.30	.....
Proximate:					
Moisture	3.32	3.10	4.14	2.97	3.55
Volatile matter	40.80	40.76	39.30	37.61	38.35
Fixed carbon	49.11	50.11	47.18	49.45	48.37
Ash	6.77	6.03	9.38	9.97	9.73
Sulphur	3.55	3.42	3.96	3.65	4.00
Ultimate:					
Hydrogen	.....	.....	5.19	5.14	4.91
Carbon	.....	.....	69.58	70.21	72.32
Nitrogen	.....	.....	1.20	1.23	1.24
Oxygen	.....	.....	10.69	9.80	7.29
Ash	.....	.....	.....	.....	10.09
Sulphur	.....	.....	.....	.....	4.15
Calorific value determined (as received) calories	.....	.....	7,152	7,185	.....
Calorific value determined (as received) B. t. u.	.....	.....	12,874	12,933	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Ohio No. 12.

	Test 483.
Size as used:	
Over 1 inch ..... per cent	23.8
½ inch to 1 inch ..... do	25.7
¼ inch to ½ inch ..... do	20.5
Under ¼ inch ..... do	30.0
Average diameter ..... inch	0.72
Duration of test ..... hours	9.05
Heating value of coal ..... B. t. u. per pound dry coal	13,381
Force of draft:	
Under stack damper ..... inch water	.85
Above fire ..... do	.21
Dry coal used per square foot of grate surface per hour ..... pounds	22.98
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	4.20
Percentage of rated horsepower of boiler developed	117.6
Water apparently evaporated per pound of coal as fired ..... pounds	7.28
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... pounds	8.81
Per pound of dry coal ..... do	9.14
Per pound of combustible ..... do	10.40
Efficiency of boiler, including grate ..... per cent	65.96
Coal as fired:	
Per indicated horsepower hour ..... pounds	3.21
Per electrical horsepower hour ..... do	3.96
Dry coal:	
Per indicated horsepower hour ..... pounds	3.09
Per electrical horsepower hour ..... do	3.82

PRODUCER-GAS TESTS.

Ohio No. 12 (run of mine).

	Test 146.	Test 147.
Size as used:		
Over 1 inch ..... per cent	62	52
½ inch to 1 inch ..... do	21	18
¼ inch to ½ inch ..... do	10	11
Under ¼ inch ..... do	7	19
Duration of test ..... hours	34	50
Average electrical horsepower	198.8	198.6
Average B. t. u. per cubic foot of gas	164.8	164.6
Total coal fired ..... pounds	10,650	14,350

PRODUCER-GAS TESTS—Continued.

Ohio No. 12 (run of mine).

	Test 146.			Test 147.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).						
Per electrical horsepower:						
Commercially available	1.65	1.60	1.44	1.51	1.45	1.28
Developed at switchboard	1.58	1.53	1.37	1.45	1.39	1.23
Per brake horsepower:						
Commercially available	1.40	1.36	1.22	1.28	1.23	1.09
Developed at engine	1.34	1.30	1.17	1.23	1.18	1.05
Equivalent used by producer plant (pounds).						
Per electrical horsepower:						
Commercially available	1.77	1.72	1.54	1.62	1.56	1.38
Developed at switchboard	1.69	1.64	1.47	1.56	1.50	1.33
Per brake horsepower:						
Commercially available	1.50	1.46	1.31	1.38	1.33	1.18
Developed at engine	1.43	1.39	1.25	1.32	1.27	1.13

Analyses.

	Test 146.	Test 147.		Test 146.	Test 147.
Coal.			*Gas by volume.*		
Moisture	2.97	3.82	Carbon dioxide (CO_2)	9.4	9.3
Volatile matter	37.61	37.77	Carbon monoxide (CO)	19.8	19.9
Fixed carbon	49.45	47.42	Hydrogen (H_2)	15.7	15.2
Ash	9.97	10.99	Methane (CH_4)	2.9	2.5
Sulphur	3.65	3.39	Nitrogen (N_2)	51.8	52.6
			Ethylene (C_2H_4)	.4	.5

WASHING TEST.

Ohio No. 12.

Test 193.—Duration of test, 50 minutes. Size as used, through 2-inch screen. Jig used, Stewart; speed, 35 r. p. m.; stroke, 6 inches. Raw coal, 6.7 tons; washed coal, 5.1 tons, 76 per cent; refuse, 1.6 tons, 24 per cent.

Analyses.

Sample tested.	Laboratory No.	Moisture.	Ash.		Sulphur.	
			Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
Raw coal, car sample	4151	4.14	9.38	.....	3.96	.....
Washed coal, test 193	4519	6.85	6.19	33	3.60	9
Refuse	.....	5.78	19.91	.....	6.62	.....

Float and sink tests.

No. of test.	Sizes as used (inch).	Specific gravity of solu- used.	Percentage of float.		Sink (per cent).	Analyses.			
						Ash.		Sulphur.	
			To refuse.	To total sample.		Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
On raw coal (preliminary):									
1	¼	1.35	.....	77	23	5.12	45	3.23	18
2	¼	1.40	.....	89	11	6.43	32	3.63	8
3	¼	1.45	.....	92	8	6.78	28	3.88	2
4	¼	1.52	.....	94	6	7.31	22	3.98	.....
On refuse (float):[a]									
1	.....	1.35	39	9.35	.....	5.75	.....	3.67	.....
2	.....	1.41	57	13.29	.....	6.42	.....	4.04	.....
3	.....	1.45	59	14.09	.....	9.12	.....	5.26	.....
4	.....	1.53	81	19.30	.....	10.17	.....	4.97	.....

[a] Loss of good coal, 9 per cent.

COKING TEST.

Ohio No. 12 (run of mine).

Test 180.—Size as used, washed, finely crushed. Duration of test, 45 hours. Coal charged, 9,270 pounds. Coke produced, 5,190 pounds; 55.99 per cent. Breeze produced, 223 pounds; 2.41 per cent. Total yield, 58.40 per cent. Light gray, with some silvery deposit of carbon; sulphur high.

Analyses.

	Coal.	Coke.
Moisture	5.19	0.73
Volatile matter	39.04	.51
Fixed carbon	48.36	87.96
Ash	6.41	10.80
Sulphur	3.63	3.08

PENNSYLVANIA.

PENNSYLVANIA NO. 7.[a]

Bituminous coal from a mine 3 miles north of Ligonier, Westmoreland County, on the Ligonier Valley Railroad, was designated "Pennsylvania No. 7."

This sample, consisting of run-of-mine coal loaded under the supervision of J. S. Burrows, was used in making steaming test 307.

[a] For other tests of coal from this mine, made during 1905, see Bull. U. S. Geol. Survey No. 290, 1906, pp. 176-178.

CHEMICAL ANALYSES.

Pennsylvania No. 7.

	Steaming test 307.[a]		Steaming test 307.[a]
Proximate:		Ultimate:	
Moisture	5.80	Hydrogen	4.37
Volatile matter	21.79	Carbon	74.41
Fixed carbon	58.78	Nitrogen	1.53
Ash	13.68	Oxygen	2.86
Sulphur	2.22	Ash	14.47
		Sulphur	2.36

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Pennsylvania No. 7 (run of mine).

	Test 307.
Size as used:	
Over 1 inch ..... per cent	16.8
½ inch to 1 inch ..... do	21.7
¼ inch to ½ inch ..... do	19.5
Under ¼ inch ..... do	42.0
Duration of test ..... hours	10.07
Heating value of coal ..... B. t. u. per pound dry coal	13,455
Force of draft:	
Under stack damper ..... inch water	0.54
Above fire ..... do	.13
Furnace temperature ..... °F.	2,220
Dry coal used per square foot of grate surface per hour ..... pounds	16.35
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	3.03
Percentage of rated horsepower of boiler developed	85.0
Water apparently evaporated per pound of coal as fired ..... pounds	7.34
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... do	8.76
Per pound of dry coal ..... do	9.29
Per pound of combustible ..... do	11.16
Efficiency of boiler, including grate ..... per cent	66.68
Coal as fired:	
Per indicated horsepower hour ..... pounds	3.23
Per electrical horsepower hour ..... do	3.99
Dry coal:	
Per indicated horsepower hour ..... do	3.04
Per electrical horsepower hour ..... do	3.76

PENNSYLVANIA NO. 11.

Bituminous coal from the Pittsburg bed at Charleroi, Washington County, on the Pennsylvania Railroad, was designated "Pennsylvania No. 11." The coal, as worked from the outcrop at this place, averages 5 feet 6 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of run-of-mine coal and was used in producer-gas test 129, coking test 159, and cupola tests 143 and 161.

Two mine samples were taken for chemical analysis. Sample 3421 was taken 4,000 feet southwest of the opening, where the coal measured 5 feet 5¾ inches in thickness. Sample 3422 was taken 4,000 feet northwest of the opening, where the coal measured 5 feet 6¾ inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 11.

	Mine samples.		Car sample.		Mine samples.		Car sample.
Laboratory No.	3421	3422	3532	Ultimate:			
Air-drying loss	1.20	1.30	0.60	Hydrogen			5.13
Proximate:				Carbon			76.86
Moisture	2.50	2.56	1.95	Nitrogen			1.44
Volatile matter	34.65	34.55	34.07	Oxygen			8.10
Fixed carbon	57.51	55.94	56.69	Ash			
Ash	5.34	6.95	7.29	Sulphur			
Sulphur	1.14	2.27	1.18	Calorific value determined (as received). calories.	7,859		7,653
				Calorific value determined (as received). B. t. u.	14,146		13,775

PRODUCER-GAS TEST.

Pennsylvania No. 11 (run of mine).

Test 129.—Duration of test, 50 hours. Average electrical horsepower, 170.7. Average B. t. u. per cubic foot of gas, 146.4. Total coal fired, 12,200 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower-hour (pounds).			
Per electrical horsepower:			
Commercially available	1.53	1.50	1.39
Developed at switchboard	1.43	1.40	1.30
Per brake horsepower:			
Commercially available	1.30	1.27	1.18
Developed at engine	1.22	1.19	1.10
Equivalent used by producer plant.			
Per electrical horsepower:			
Commercially available	1.66	1.63	1.51
Developed at switchboard	1.55	1.52	1.41
Per brake horsepower:			
Commercially available	1.41	1.38	1.28
Developed at engine	1.32	1.29	1.20

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	10.4
Carbon monoxide (CO)	18.5
Hydrogen (H_2)	16.3
Methane (CH_4)	2.0
Nitrogen (N_2)	52.6
Ethylene (C_2H_4)	.2

COKING TEST.

Pennsylvania No. 11 (run of mine).

Test 159.—Size as used, raw, finely crushed. Duration of test, 41 hours. Coal charged, 12,040 pounds. Coke produced, 8,100 pounds; 67.28 per cent. Breeze produced, 296 pounds; 2.46 per cent. Total yield, 69.74 per cent. Light-gray color. Good coke.

Analysis.

	Coal.	Coke.
Moisture	2.20	0.52
Volatile matter	33.18	.97
Fixed carbon	55.46	85.02
Ash	9.16	13.49
Sulphur	1.36	1.19
Phosphorus		.0307

[a] For analyses of fuel used, see above (sample 3532).

Cupola tests of coke made from Pennsylvania No. 11 coal.

CHARGE.

Cupola test No.	Coke. Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
143	159	1.92	7	97.22	Coke	200	58	58	57	57	430
					Pig iron	800	550	550	550	550	3,000
161	159	1.92	6	93.75	Coke	220	70	70	70	70	500
					Pig iron	880	530	530	530	530	3,000

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Maximum.	Iron running in—	Weight of iron. Poured.	Additional melted.	Total.	Melting. Time.	Rate per hour.	Ratio iron to coke.	Loss.	Recovered. Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
143	3.08 p. m.	7	10	1,636	278	1,914	34	3,378	5.33	4.63	947	71
161	1.58 p. m.	7	10	2,054	542	2,596	28	5,563	6.12	4.40	272	76

LADLE RECORD.

Ladle No.	Test 143. Pounds.	Time (p. m.)	Test 161. Pounds.	Time (p. m.)	Ladle No.	Test 143. Pounds.	Time (p. m.)	Test 161. Pounds.	Time (p. m.)
1	68	3.22	93	2.12	13	80	3.39	73	2.26
2	72	3.24	110	2.13	14	93	3.43	64	2.28
3	104	3.26	80	2.16	15	85	3.43½	86	2.28½
4	90	3.27	82	2.16½	16	93	3.44	132	2.29
5	90	3.32	125	2.17	17	78	3.48	66	2.30
6	101	3.32½	68	2.22	18	100	3.49	94	2.30½
7	87	3.33	73	2.22½	19	28	3.52	134	2.31
8	93	3.35	59	2.23	20			61	2.33
9	99	3.35½	109	2.23½	21			83	2.33½
10	87	3.36	137	2.24	22			99	2.34
11	86	3.38	70	2.25	23			37	2.36
12	102	3.38½	119	2.25½					

SILICON, MANGANESE, ETC.

Cupola test No.	Materials.	Amount used (pounds)	Silicon. Per cent.	Silicon. Pounds.	Manganese. Per cent.	Manganese. Pounds.	Sulphur. Per cent.	Sulphur. Pounds.	Content of coke combined with iron melted (per cent).
143	Pig iron		2.12	40.58	0.178	3.407	0.059	1.1293	
	Melted iron:								
	Amount		1.85	35.41	.111	2.124	.070	1.3398	4.83
	Gain or loss		−12.74	− 5.17	−37.66	−1.283	+ .011	+ .2105	
	Coke	366					1.19	4.3554	
161	Pig iron		2.10	54.52	.163	4.231	.098	2.5441	
	Melted iron:								
	Amount		1.74	45.17	.113	2.933	.113	2.9335	7.57
	Gain or loss		−17.15	− 9.35	−30.68	−1.298	+ .015	+ .3894	
	Coke	432					1.19	5.1408	

Remarks.—Test 143: Pig iron used from car 27633. Iron hot. Test 161: Pig iron used from car 131943. Iron cold.

PENNSYLVANIA NO. 12.

Bituminous coal from the Pittsburg bed at Acheson, Washington County, on the Baltimore and Ohio Railroad, was designated Pennsylvania No. 12. The coal, as worked from the outcrop at this place, averages 5 feet 1 inch in thickness.

One sample, shipped under the supervision of John W. Groves, consisting of run-of-mine coal, was used in producer-gas test 143, washing test 179, coking tests 161 and 162, and cupola tests 145, 146, 151, 152, 153, and 154.

Two mine samples were taken for chemical analysis. Sample 3441 was taken 1,100 feet west of the opening, where the coal measured 5 feet 3¼ inches in thickness. Sample 3442 was taken 1,600 feet southwest of the opening, where the coal measured 4 feet 11 inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 12 (run of mine).

	Mine samples.		Car sample.		Mine samples.		Car sample.
Laboratory No.	3441	3442	4098	Ultimate:			
Air-drying loss	1.40	2.00	0.70	Hydrogen			4.81
Proximate:				Carbon			74.37
Moisture	2.60	3.21	1.96	Nitrogen			1.45
Volatile matter	32.46	32.27	30.55	Oxygen			7.93
Fixed carbon	59.31	58.64	58.24	Calorific value determined (as received) calories	7,880		7,568
Ash	5.63	5.88	9.25	Calorific value determined (as received) B. t. u.	14,184		13,622
Sulphur	1.19	1.22	2.19				

PRODUCER-GAS TEST.

Pennsylvania No. 12 (run of mine).

Test 143.—Size as used: Over 1 inch, 20 per cent; ½ to 1 inch, 17 per cent; ¼ inch to ½ inch, 18 per cent; under ¼ inch, 45 per cent. Duration of test, 28 hours. Average electrical horsepower, 195.3. Average B. t. u. per cubic foot of gas, 147.5. Total coal fired, 6,100 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.16	1.14	1.03
Developed at switchboard	1.12	1.09	.99
Per brake horsepower:			
Commercially available	.99	.97	.88
Developed at engine	.95	.93	.84
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.28	1.26	1.14
Developed at switchboard	1.23	1.21	1.09
Per brake horsepower:			
Commercially available	1.09	1.07	.97
Developed at engine	1.05	1.03	.93

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	10.8
Carbon monoxide (CO)	16.6
Hydrogen (H_2)	14.9
Methane (CH_4)	2.4
Nitrogen (N_2)	54.8
Ethylene (C_2H_4)	.5

[a] For analysis of fuel used see above (sample 4098).

WASHING AND COKING TESTS.

Pennsylvania No. 12 (run of mine).

Washing test 179.—Size as used, 2-inch. Jig used, Stewart. Raw coal, 21,200 pounds. Washed coal, 16,900 pounds; 80 per cent. Refuse, 4,300 pounds; 20 per cent.

Coking tests.

		Test 161 (raw).	Test 162 (w.).
Size as used		f. c.	f. c.
Duration of test	hours.	47	48
Coal charged	pounds.	11,950	12,140
Coke produced	do.	7,885	8,100
	per cent.	65.98	66.72
Breeze produced	pounds.	286	257
	per cent.	2.39	2.12
Total yield	do.	68.37	68.84

Remarks.—Test 161: Light gray and silvery; fair coke. Test 162: Light gray and silvery; good coke. Ash and sulphur reduced by washing.

Analyses.

	Washing test 179.		Coking test 161.		Coking test 162.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	1.96	4.63	2.46	0.69	4.50	0.52
Volatile matter	30.55	.....	31.28	.29	31.35	1.28
Fixed carbon	58.24	.....	56.70	86.29	57.66	89.13
Ash	9.25	6.40	9.56	12.73	6.49	9.07
Sulphur	2.19	1.39	2.03	1.66	1.40	1.11
Phosphorus	.....	.....	.....	.0184	.....	.0087

Cupola tests of coke made from Pennsylvania No. 12 coal.

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
145	161	1.97	7	97.22	Coke	210	55	55	55	55	430
					Pig iron	840	540	540	540	540	3,000
146	162 (w.)	1.95	7	99.9	Coke	210	55	55	55	55	430
					Pig iron	840	540	540	540	540	3,000
151	161	1.97	6	96.53	Coke	220	70	70	70	70	500
					Pig iron	880	530	530	530	530	3,000
152	161	1.97	8	98.61	Coke	200	44	44	44	43	375
					Pig iron	800	550	550	550	550	3,000
153	162 (w.)	1.95	6	99.9	Coke	210	73	73	72	72	500
					Pig iron	840	540	540	540	540	3,000
154	162 (w.)	1.95	8	97.22	Coke	220	38¾	38¾	38¾	38¾	375
					Pig iron	880	530	530	530	530	3,000

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
145	3.13 p. m.	7	11	1,439	1,139	2,578	41	7,031	7.41	9.17	147	82
146	11.14 a. m.	7	12	1,831	205	2,036	34	3,590	6.08	4.07	812	95
151	3.29 p. m.	7	11	2,382	256	2,638	35	4,522	6.26	5.03	211	79
152	10.39 a. m.	7	8	1,841	450	2,291	33	4,165	7.61	4.10	586	74
153	2.56 p. m.	7	11	2,352	120	2,472	36	3,917	5.96	4.66	388	85
154	10.57 a. m.	7	9	2,162	355	2,517	31	4,872	8.50	5.80	309	79

Cupola tests of coke made from Pennsylvania No. 12 coal—Continued.

LADLE RECORD.

Ladle No.	Test 145.		Test 146.		Test 151.		Test 152.		Test 153.		Test 154.	
	Lbs.	Time (p. m.).	Lbs.	Time (a. m.).	Lbs.	Time (p. m.).	Lbs.	Time (a. m.).	Lbs.	Time (p. m.).	Lbs.	Time (a. m.).
1	106	3.32	100	11.30	55	3.43	97	10.53	95	3.11	92	11.15
2	112	3.32½	97	11.32	98	3.46	96	10.59	29	3.11½	133	11.15½
3	103	3.35	100	11.33	55	3.46½	110	10.59½	97	3.14	78	11.16
4	91	3.35½	101	11.34	94	3.49	91	11.00	95	3.14½	122	11.16½
5	100	3.36	88	11.38	103	3.49½	95	11.04	108	3.18	93	11.19
6	97	3.37	110	11.38½	96	3.50	101	11.04½	108	3.18½	93	11.19½
7	89	3.38	69	11.39	90	3.53	112	11.05	108	3.19	93	11.20
8	87	3.38½	151	11.42	101	3.53½	118	11.05½	102	3.23	135	11.22
9	106	3.39	111	11.42½	105	3.54	100	11.07	108	3.23½	95	11.22½
10	59	3.52	112	11.43	77	3.59	107	11.07½	112	3.24	109	11.23
11	50	3.52½	103	11.48	107	3.59½	106	11.08	99	3.25	101	11.25
12	68	3.59	163	11.48½	145	4.00	89	11.10	100	3.25½	73	11.25½
13	72	4.00	95	11.49	106	4.00½	104	11.10½	100	3.26	86	11.26
14	82	4.01	96	11.55	100	4.01	107	11.11	101	3.29	113	11.28
15	65	4.02	114	11.55½	99	4.03	105	11.14	100	3.29½	73	11.28½
16	59	4.04	89	11.56	117	4.03½	110	11.14½	115	3.30	93	11.29
17	70	4.04½	60	11.58	83	4.04	111	11.15	90	3.32	118	11.31
18	23	4.05	72	12.00	76	4.08	57	11.19	99	3.34	73	11.31½
19					107	4.08½	25	11.20	109	3.34½	100	11.32
20					105	4.09			85	3.35	114	11.35
21					109	4.10			98	3.40	70	11.35½
22					71	4.10½			102	3.40½	88	11.36
23					108	4.11			103	3.41	17	11.37
24					109	4.11½			89	3.43		
25					66	4.15						

SILICON, MANGANESE, ETC.

Cupola test No.	Materials.	Amount used (pounds).	Silicon.		Manganese.		Sulphur.		Content of coke combined with iron melted (per ct.)
			Per cent.	Pounds.	Per cent.	Pounds.	Per cent.	Pounds.	
145	Pig iron		2.12	54.65	0.178	4.589	0.059	1.5216	4.35
	Melted iron:								
	Amount		1.89	48.72	.133	3,429	.069	1.7788	
	Gain or loss		−10.85	−5.93	−25.28	−1.160	+.010	+.2572	
	Coke	356					1.66	5.9096	
146	Pig iron		2.12	43.16	.178	3.624	.059	1.2012	11.20
	Melted iron:								
	Amount		1.84	37.46	.141	2.871	.080	1.6288	
	Gain or loss		−13.21	−5.70	−20.78	−.753	+.021	+.4276	
	Coke	344					1.11	3.8184	
151	Pig iron		2.12	55.93	.178	4.696	.059	1.5564	5.94
	Melted iron:								
	Amount		1.91	50.39	.123	3.245	.078	2.0576	
	Gain or loss		−9.90	−5.54	−30.90	−1.451	+.019	+.5012	
	Coke	429					1.66	8.4414	
152	Pig iron		2.12	48.57	.178	4.078	.059	1.3517	4.92
	Melted iron:								
	Amount		1.86	42.61	.130	2.978	.070	1.6037	
	Gain or loss		−12.28	−5.96	−26.97	−1.100	+.011	+.2520	
	Coke	308					1.66	5.1128	
153	Pig iron		2.12	52.41	.178	4.400	.059	1.4585	15.27
	Melted iron:								
	Amount		1.78	44.00	.218	3.164	.088	2.1754	
	Gain or loss		−16.05	−8.41	−28.09	−1.236	+.029	+.7169	
	Coke	423					1.11	4.69.53	
154	Pig iron		2.12	53.36	.178	4.480	.059	1.4850	11.13
	Melted iron:								
	Amount		1.81	45.56	.136	3.423	.074	1.8626	
	Gain or loss		−14.62	−7.80	−23.59	−1.057	+.016	+.3776	
	Coke	304					1.11	3.3744	

Remarks.—Pig iron used from car 27633. Test 145: Iron hot. Blast off 19 minutes; melting too fast to handle. Tests 146, 151, 152, and 153: Iron hot. Test 154: Temperature of iron medium.

PENNSYLVANIA NO. 13.

Bituminous coal from the Freeport bed at Creighton, Allegheny County, on the Pennsylvania Railroad, was designated Pennsylvania No. 13. The coal, as worked from the outcrop at this place, averages 5 feet 10 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of run-of-mine coal and was used in producer-gas tests 136 and 140.

Two mine samples were taken for chemical analysis. Sample 3437 was taken 4,800 feet northwest of the opening, where the coal measured 6 feet 1 inch in thickness. Sample 3438 was taken 5,500 feet northwest of the opening, where the coal measured 5 feet 8 inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 13.

	Mine samples.		Car sample.		Mine samples.		Car sample
Laboratory No.	3437	3438	3879	Ultimate:			
Air-drying loss	1.00	1.30	1.40	Hydrogen			5.11
Proximate:				Carbon			70.25
Moisture	2.53	2.93	2.65	Nitrogen			1.21
Volatile matter	33.99	34.02	33.02	Oxygen			8.11
Fixed carbon	54.50	55.52	51.17	Calorific value determined (as received). calories	7,420		7,120
Ash	8.98	7.53	13.16	B. t. u.	13,356		12,816
Sulphur	2.21	1.87	2.16				

PRODUCER-GAS TESTS.

Pennsylvania No. 13 (run of mine).

	Test 136.	Test 140.
Size as used:		
Over 1 inch, per cent	65	49
½ inch to 1 inch, do	15	24
¼ inch to ½ inch, do	8	12
Under ¼ inch, do	12	15
Duration of test, hours	50	50
Average electrical horsepower	193.2	196.5
Average B. t. u. per cubic foot of gas	153.0	144.9
Total coal fired, pounds	12,600	11,750

	Test 136.			Test 140.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).						
Per electrical horsepower:						
Commercially available	1.36	1.33	1.15	1.25	1.23	1.08
Developed at switchboard	1.30	1.27	1.10	1.20	1.18	1.03
Per brake horsepower:						
Commercially available	1.16	1.13	.98	1.06	1.04	.92
Developed at engine	1.11	1.08	.93	1.02	1.00	.08
Equivalent used by producer plant (pounds).						
Per electrical horsepower:						
Commercially available	1.49	1.45	1.25	1.36	1.34	1.19
Developed at switchboard	1.42	1.38	1.20	1.30	1.28	1.12
Per brake horsepower:						
Commercially available	1.26	1.23	1.06	1.16	1.14	1.00
Developed at engine	1.21	1.18	1.02	1.10	1.09	.95

Analyses.

	Test 136.	Test 140.		Test 136.	Test 140.
Coal.			*Gas by volume.*		
Moisture	2.65	1.65	Carbon dioxide (CO_2)	11.0	11.1
Volatile matter	33.02	33.06	Carbon monoxide (CO)	17.2	11.5
Fixed carbon	51.17	53.22	Hydrogen (H_2)	14.9	12.6
Ash	13.16	12.07	Methane (CH_4)	2.4	2.1
Sulphur	2.16	1.80	Nitrogen (N_2)	54.0	57.1
			Ethylene (C_2H_4)	.5	.6

PENNSYLVANIA NO. 15.

Bituminous coal from the "Miller" or B bed at Wehrum, Indiana County, on the Pennsylvania Railroad, was designated Pennsylvania No. 15. The coal, as worked at a depth of 187 feet at this place, averages 3 feet 10 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of run-of-mine coal, and was used in steaming tests 467 (on briquets), 472, and 473; producer-gas test 144; washing test 188; coking tests 185 and 188; and briquetting tests 176 and 184† (mixed with Rhode Island No. 1, see p. 223).

Two mine samples were taken for chemical analysis. Sample 4026 was taken 2,000 feet northeast of the shaft, where the coal measured 4 feet 2½ inches in thickness. Sample 4027 was taken 1,900 feet southwest of the shaft, where the coal measured 3 feet 6 inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 15.

	Mine samples.		Car samples.		Steaming tests.[a]			Briquetting test 184†.[b]
					472.	473.	467.	
Laboratory No.	4026	4027	4082	4104	.....	.....	.....	4913
Air-drying loss	3.30	2.40	2.80	2.10	.....	.....	.....	.....
Proximate:								
Moisture	3.83	2.84	3.13	2.57	1.88	2.45	3.90	0.74
Volatile matter	19.03	17.47	17.61	18.09	17.60	17.55	23.35	15.96
Fixed carbon	67.89	71.42	69.45	69.01	69.06	70.56	64.65	69.71
Ash	9.25	8.27	9.81	10.33	11.46	9.44	8.10	13.59
Sulphur	4.57	3.11	3.77	3.97	5.37	3.87	3.11	2.61
Ultimate:								
Hydrogen	.....	.....	4.62	4.43	4.13	4.31	4.35	3.05
Carbon	.....	.....	76.41	75.89	75.63	78.83	78.71	77.48
Nitrogen	.....	.....	1.14	1.16	1.15	1.21	1.09	.49
Oxygen	.....	.....	4.25	4.22	1.94	2.00	4.18	2.65
Ash	.....	.....	.....	.....	11.68	9.68	8.43	13.70
Sulphur	.....	.....	.....	.....	5.47	3.97	3.24	2.63
Calorific value determined (as received)	calories	7,821	7,664	7,618	.....	.....	.....	.....
	B. t. u.	14,079	13,795	13,712	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Pennsylvania No. 15 (run of mine).

	Test 472.	Test 473.	Test 467.
Size as used:			
Over 1 inch.....per cent..	8.2	4.6	See p. 204.
½ inch to 1 inch.....do....	11.1	6.9	
¼ inch to ½ inch.....do....	19.2	13.9	
Under ¼ inch.....do....	61.5	74.6	
Average diameter.....inch..	0.41	0.31	
Duration of test.....hours..	8.75	9.77	8.87
Heating value of fuel.....B. t. u. per pound of dry fuel..	13,729	14,240	14,258
Force of draft:			
Under stack damper.....inch water..	0.81	0.82	0.76
Above fire.....do....	.27	.23	.17
Furnace temperature.....°F..	2,512	2,615	2,753
Dry fuel used per square foot of grate surface per hour.....pounds..	16.87	17.24	17.63
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.00	3.25	3.53
Percentage of rated horsepower of boiler developed.....	84.2	91.2	99.00
Water apparently evaporated per pound of fuel as fired.....pounds..	7.27	7.65	7.98
Water evaporated from and at 212° F.:			
Per pound of fuel as fired.....do....	8.76	9.22	9.65
Per pound of dry fuel.....do....	8.93	9.45	10.04
Per pound of combustible.....do....	10.57	10.85	11.30
Efficiency of boiler, including grate.....per cent..	62.81	64.09	68.00
Fuel as fired:			
Per indicated horsepower hour.....pounds..	3.23	3.07	2.93
Per electrical horsepower hour.....do....	3.99	3.79	3.62
Dry fuel:			
Per indicated horsepower hour.....do....	3.17	2.99	2.82
Per electrical horsepower hour.....do....	3.91	3.69	3.48

Remarks.—Test 467 on Renfrow briquets from test 176, which burned freely with short flame, 5.4 per cent black smoke, and very hot fire; briquets coking well and throwing off fragments of coke in ash during combustion; 39 per cent clinker, thin, metallic, red and black, brittle when cold; ash of dark gray color, looked like coke.

PRODUCER-GAS TEST.

Pennsylvania No. 15 (lump).

Test 144.—Size as used: Over 1 inch, 7 per cent; ½ inch to 1 inch, 14 per cent; ¼ inch to ½ inch, 18 per cent; under ¼ inch, 61 per cent. Duration of test, 24 hours. Average electrical horsepower, 191.8. Average B. t. u. per cubic foot of gas, 144.4. Total coal fired, 5,700 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.29	1.26	1.12
Developed at switchboard	1.24	1.21	1.08
Per brake horsepower:			
Commercially available	1.10	1.07	.96
Developed at engine	1.05	1.03	.92
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.43	1.39	1.25
Developed at switchboard	1.37	1.34	1.20
Per brake horsepower:			
Commercially available	1.22	1.18	1.06
Developed at engine	1.17	1.14	1.02

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	10.7
Carbon monoxide (CO)	17.2
Hydrogen (H_2)	15.8
Methane (CH_4)	2.2
Nitrogen (N_2)	53.8
Ethylene (C_2H_4)	.3

[a] For analyses of fuel used see p. 201 (sample 4104).

WASHING TESTS.

Pennsylvania No. 15.

Test 188.—Duration of test, 2 hours. Size as used, through 1-inch screen. Jig used, special; speed, 70 r. p. m.; stroke, 2½ inches. Raw coal, 20.37 tons; washed coal, 15.25 tons, 75 per cent; refuse, 5.12 tons, 25 per cent.

Analyses.

Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur.	
			Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
Raw coal, car sample	4082	3.13	9.81	.....	3.77	.....
Washed coal, test 188	4597	6.45	5.38	45	1.53	59
Refuse	.....	5.78	47.18	.....	19.78	.....

Float and sink tests.

No. of test.	Size used (inch).	Specific gravity of solution used.	Percentage of float.		Sink (per cent).	Analysis.			
						Ash.		Sulphur.	
			To refuse.	To total sample.		Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
On raw coal (preliminary):									
1	½	1.35	.....	72	28	5.47	44	1.30	66
2	½	1.41	.....	78	22	5.27	46	1.45	62
3	½	1.45	.....	80	20	5.54	43	1.54	59
4	½	1.52	.....	81	19	6.26	36	1.71	55
On refuse (float):[a]									
1	.....	1.35	11.80	2.95	.....	4.95	.....	1.71	.....
2	.....	1.41	13.20	3.30	.....	6.50	.....	2.13	.....
3	.....	1.46	14.50	3.64	.....	7.65	.....	2.29	.....
4	.....	1.51	17.20	4.30	.....	8.15	.....	2.88	.....

[a] Figures indicate that finer crushing is advantageous. Loss of "good coal" in the refuse will not exceed 2 per cent. By "good coal" is meant all coal of a quality equal to or better than that of the washed coal.

COKING TESTS.

Pennsylvania No. 15 (run of mine, washed).

	Test 185.	Test 188.
Size as used	f. c.	r. o. m.
Duration of test, hours	61	54
Coal charged, pounds	9,750	12,460
Coke produced, do	5,779	8,144
Coke produced, per cent	59.27	65.36
Breeze produced, pounds	262	332
Breeze produced, per cent	2.69	2.66
Total yield, do	61.96	68.02

Remarks.—Test 185: Dull-gray color; soft dense coke; high sulphur. Test 188: Light gray and silvery; much better than coke from finely ground coal; high sulphur.

Analyses.

	Test 185.		Test 188.	
	Coal.	Coke.	Coal.	Coke.
Moisture	7.19	0.56	4.53	0.57
Volatile matter	17.86	.32	18.56	.55
Fixed carbon	69.57	91.10	70.63	90.23
Ash	5.38	8.02	6.28	8.65
Sulphur	1.63	1.46	1.85	1.54

BRIQUETTING TESTS.

Pennsylvania No. 15 (run of mine.)

Test 176.—Size as used: Over ½ inch, 2.2 per cent; $\frac{1}{10}$ inch to ½ inch, 6 per cent; $\frac{1}{20}$ inch, to $\frac{1}{10}$ inch, 12 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 19 per cent; through $\frac{1}{10}$ inch, 60.8 per cent. This test, with 7 per cent binder, gave satisfactory briquets, which were tough and easily handled without breaking when warm, but brittle when cold. Broke with characteristic smooth glossy fracture, hard surface, and sharp edges. For analyses of briquets see page 201 (steaming test 467).

Test 184†.—Size as used: Over ½ inch, 0.8 per cent; $\frac{1}{10}$ inch, to ½ inch, 7 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 15 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 22.2 per cent; through $\frac{1}{40}$ inch, 55 per cent. Pennsylvania No. 15 was mixed with an equal portion of Rhode Island No. 1 (run of mine) in this test. Excellent briquets were made with 6.25 per cent binder on the Renfrow machine. Although the pitch used had a low melting point, the briquets handled well from the machine, and piled without sticking. The outer surface was very hard and smooth, and broke without crumbling, giving a smooth fracture and sharp edges. For analyses of briquets see page 201.

	Test 176.	Test 184†.		Test 176.	Test 184†.
Details of manufacture:			Tumbler test (1-inch screen):		
Machine used	Renf.	Renf.	Held ..... per cent	70.5	93.0
Temperature of briquets. °F.	185	185	Passed (fines) ..... do	29.5	7.0
Binder—			Fines through 10-mesh sieve ..... per cent	85.0	91.4
Kind	w. g. p.	w. g. p.	Weathering test:		
Laboratory No. (see p. 40)	4553	4543	Time exposed ..... days	53	11
Amount ..... per cent	7	6.25	Condition	A.	A.
Weight of—			Water absorption:		
Fuel briquetted. pounds	8,000	10,000	In 19 days ..... per cent	22.0	.....
Briquets, average. do	0.420	0.5	In 16 days ..... do	.....	13.3
Heat value per pound—			Average for first—		
Fuel as received. B. t. u.	13,712	[a] 13,712 [b] 10,996	4 days ..... do	4.05	.....
Fuel as fired ..... do	13,702	12,793	5 days ..... do	.....	1.90
Binder	16,969	16,969	Specific gravity (apparent)	1.043	1.275
Drop test (1-inch screen):					
Held ..... per cent	50.5	68.5			
Passed ..... do	49.5	31.5			

[a] Pennsylvania No. 15. [b] Rhode Island No. 1 (see p. 223).

Extraction analyses.

	Pitch.	Fuel.		Briquets.	
		Pa. No. 15.	R. I. No. 1.	Test 176.	Test 184†.
Laboratory No	4543	4104	3141	.....	4913
Air-drying loss ..... per cent	.....	2.10	3.40	2.80	0.03
Extracted by CS_2:					
Air-dried ..... do	.....	.79	.02	5.89	6.27
As received ..... do	99.66	.77	.02	5.72	6.25
Pitch in briquets, as received ..... do	.....	.....	.....	5.02	5.91

PENNSYLVANIA NO. 16.

Bituminous coal from the D bed at Hastings, Cambria County, on the Pennsylvania Railroad, was designated Pennsylvania No. 16. The coal, as worked from the outcrop at this place, averages 4 feet 4 inches in thickness.

One sample, shipped under the supervision of K. M. Way, consisted of run-of-mine coal, and was used in steaming tests 468 (on briquets) and 471, producer-gas test 148, and briqueting tests 172, 173, and 174.

Two mine samples were taken for chemical analysis. Sample 4028 was taken several hundred feet from the opening, where the coal measured 4 feet 6 inches in thickness. Sample 4029 was taken on the other side of the mine, where the coal measured 4 feet 2 inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 16.

	Mine samples.		Car Sample.	Steaming tests.[a]	
				468.	471.
Laboratory No	4028	4029	4169	4253	.....
Air-drying loss	2.30	2.30	3.90	.....	.....
Proximate:					
Moisture	2.86	2.74	4.25	5.27	4.16
Volatile matter	22.64	22.66	21.79	23.69	21.07
Fixed carbon	67.71	67.37	66.09	62.69	65.84
Ash	6.79	7.23	7.87	8.35	8.93
Sulphur	1.42	1.51	1.59	1.68	1.60
Ultimate:					
Hydrogen	.....	.....	4.72	4.36	4.38
Carbon	.....	.....	75.92	79.42	78.32
Nitrogen	.....	.....	1.28	1.29	1.33
Oxygen	.....	.....	8.62	4.35	4.98
Ash	.....	.....	.....	8.81	9.32
Sulphur	.....	.....	.....	1.77	1.67
Calorific value determined (as received)..calories	.....	7,858	7,507	.....	.....
Calorific value determined (as received)..B. t. u.	.....	14,144	13,513	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Pennsylvania No. 16 (run of mine).

	Test 468.	Test 471.
Size as used:		
Over 1 inch....per cent..	See p. 206.	7.2
½ inch to 1 inch....do....		11.6
¼ inch to ½ inch....do....		18.8
Under ¼ inch....do....		62.4
Average diameter....inch..		.39
Duration of test....hours..	8.10	10.03
Heating value of fuel....B. t. u. per pound dry fuel..	14,238	13,939
Force of draft:		
Under stack damper....inch water..	0.73	0.76
Above fire....do....	.14	.20
Furnace temperature....°F..	2,855	2,785
Dry fuel used per square foot of grate surface per hour....pounds..	19.04	18.52
Equivalent water evaporated per square foot of water-heating surface per hour, pounds....	3.77	3.53
Percentage of rated horsepower of boiler developed....	105.7	98.90
Water apparently evaporated per pound of fuel as fired....pounds..	7.78	7.59
Water evaporated from and at 212° F.:		
Per pound of fuel as fired....do....	9.40	9.15
Per pound of dry fuel....do....	9.92	9.55
Per pound of combustible....do....	11.03	11.03
Efficiency of boiler, including grate....per cent..	67.28	66.16
Fuel as fired:		
Per indicated horsepower hour....pounds..	3.01	3.09
Per electrical horsepower hour....do....	3.71	3.82
Dry fuel:		
Per indicated horsepower hour....do....	2.85	2.96
Per electrical horsepower hour....do....	3.52	3.66

Remarks.—Test 468 on briquets, equal weights, from tests 172, 173, and 174. Briquets from both machines burned slowly with very hot fire, medium length flame, and no smoke; 41 per cent heavy, rough, brittle clinker of gray color; small amount of fine unburnt coal contained in ash.

PRODUCER-GAS TEST.

Pennsylvania No. 16 (run of mine).

Test 148.—Duration of test, 50 hours. Average electrical horsepower, 199.2. Average B. t. u. per cubic foot of gas, 149.5. Total coal fired, 9,950 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.04	0.99	0.90
Developed at switchboard	1.00	.95	.87
Per brake horsepower:			
Commercially available	.89	.84	.77
Developed at engine	.85	.80	.74
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.17	1.11	1.01
Developed at switchboard	1.12	1.06	.97
Per brake horsepower:			
Commercially available	.99	.94	.86
Developed at engine	.95	.90	.82

Analyses.

Coal.		*Gas by volume.*	
Moisture	5.32	Carbon dioxide (CO_2)	10.1
Volatile matter	21.75	Carbon monoxide (CO)	18.2
Fixed carbon	64.94	Hydrogen (H_2)	15.8
Ash	7.99	Methane (CH_4)	2.3
Sulphur	1.60	Nitrogen (N_2)	53.2
		Ethylene (C_2H_4)	.4

BRIQUETTING TESTS.

Pennsylvania No. 16 (run of mine).

Tests 172, 173, 174.—Size as used: Over $\frac{1}{4}$ inch, 2.2 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 5.4 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 11.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 21.4 per cent; through $\frac{1}{40}$ inch, 59.8 per cent. There was no difference in physical appearance between English briquets with 6 and those with 7 per cent binder. All briquets were satisfactory, with smooth, very hard surface, characteristic glossy fracture, and sharp edges. Renfrow briquets broke without crumbling and were easily handled from machine when warm. For analyses of briquets see page 205 (steaming test 468).

	Test 172.	Test 173.	Test 174.
Details of manufacture:			
Machine used	Eng.	Eng.	Renf.
Temperature of briquets °F.	203	203	185
Binder—			
Kind	c. t. p.	c. t. p.	c. t. p.
Laboratory No. (see p. 40)	4319	4319	4319
Amount per cent.	6	7	7
Weight of—			
Fuel briquetted pounds.	3,500	3,500	5,000
Briquets, average do.	3.66	3.69	0.428
Heat value per pound—			
Fuel as received B. t. u.	13,513	13,513	13,513
Fuel as fired do.	13,487	13,487	13,487
Binder do.	16,139	16,139	16,139
Drop test (1-inch screen):			
Held per cent.	76.1	80.4	44.5
Passed do.	23.9	19.6	55.5
Tumbler test (1-inch screen):			
Held do.	78.8	81.7	69.5
Passed (fines) do.	21.2	18.3	30.5
Fines through 10-mesh sieve do.	64.0	63.9	91.0
Weathering test:			
Time exposed days.	54	50	54
Condition	A.	A.	B.
Water absorption:			
In 19 days per cent.	13.9	14.7	19.0
Average for first 4 days do.	1.35	1.30	3.30
Specific gravity (apparent)	1.113	1.110	1.056

Extraction analyses.

	Pitch.	Fuel.	Briquets, tests 172, 173, 174.
Laboratory No	4319	4169	4253
Air-drying loss, per cent		3.90	4.50
Extracted by CS_2:			
Air-dried, do		.06	5.60
As received, do	66.25	.06	5.35
Pitch in briquets, as received, do			8.00

PENNSYLVANIA NO. 17.

Bituminous coal from the Upper Freeport or E bed at White, Indiana County, on the Pennsylvania Railroad, was designated Pennsylvania No. 17. The coal, as worked from the outcrop at this place, averages 3 feet 3 inches in thickness.

One sample, shipped under the supervision of A. K. Adams, consisted of run-of-mine coal, and was used in steaming tests 496 and 506, producer-gas test 158, washing test 189, and coking tests 178 (raw) and 186 (washed).

Two mine samples were taken for chemical analysis. Sample 4336 was taken 700 feet southwest of the opening, where the coal measured 3 feet 3½ inches in thickness. Sample 4337 was taken 485 feet west of the opening, where the coal measured 3 feet 3 inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 17.

	Mine samples.		Car sample.	Steaming tests.[a]	
				496.	506.
Laboratory No	4336	4337	4421		
Air-drying loss	1.30	1.30	3.30		
Proximate:					
Moisture	2.22	2.22	4.35	3.45	2.81
Volatile matter	30.91	30.95	27.76	28.33	27.91
Fixed carbon	59.67	58.41	55.99	55.62	57.85
Ash	7.20	8.42	11.90	12.60	11.43
Sulphur	1.39	1.54	1.51	1.55	1.66
Ultimate:					
Hydrogen			5.04	4.73	4.79
Carbon			71.62	74.32	75.36
Nitrogen			1.39	1.44	1.46
Oxygen			8.54	4.85	4.92
Ash				13.05	11.76
Sulphur				1.61	1.71
Calorific value determined (as received), calories		7,767	7,202		
Calorific value determined (as received), B. t. u.		13,801	12,964		

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Pennsylvania No. 17 (run of mine).

	Test 496.	Test 506.
Size as used:		
Over 1 inch ..... per cent	14.4	6.3
½ inch to 1 inch ..... do	28.1	15.8
¼ inch to ½ inch ..... do	22.3	22.1
Under ¼ inch ..... do	35.2	55.8
Average diameter ..... inch	0.62	0.43
Duration of test ..... hours	10.00	9.23
Heating value of coal ..... B. t. u. per pound of dry coal	13,455	13,644
Force of draft:		
Under stack damper ..... inch water	0.86	0.76
Above fire ..... do	.21	.06
In ash pit ..... do		.32
Furnace temperature ..... °F	2,768	2,444
Dry coal used per square foot of grate surface per hour ..... pounds	20.00	20.00
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.63	3.50
Percentage of rated horsepower of boiler developed	101.8	98.00
Water apparently evaporated per pound of coal as fired ..... pounds	7.28	7.02
Water evaporated from and at 212° F.:		
Per pound of coal as fired ..... do	8.78	8.51
Per pound of dry coal ..... do	9.09	8.76
Per pound of combustible ..... do	10.76	10.16
Efficiency of boiler, including grate ..... per cent	65.24	62.00
Coal as fired:		
Per indicated horsepower hour ..... pounds	3.22	3.32
Per electrical horsepower hour ..... do	3.98	4.10
Dry coal:		
Per indicated horsepower hour ..... do	3.11	3.23
Per electrical horsepower hour ..... do	3.84	3.99

PRODUCER-GAS TEST.

Pennsylvania No. 17 (run of mine).

Test 158.—Duration of test, 50 hours. Average electrical horsepower, 188.4. Average B. t. u. per cubic foot of gas, 141.2. Total coal fired, 13,200 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.46	1.39	1.21
Developed at switchboard	1.40	1.34	1.16
Per brake horsepower:			
Commercially available	1.24	1.19	1.03
Developed at engine	1.19	1.14	0.99
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.55	1.48	1.28
Developed at switchboard	1.49	1.42	1.23
Per brake horsepower:			
Commercially available	1.31	1.26	1.09
Developed at engine	1.26	1.21	1.05

Analyses.

Coal.		*Gas by volume.*	
Moisture	4.40	Carbon dioxide (CO_2)	10.0
Volatile matter	28.01	Carbon monoxide (CO)	17.5
Fixed carbon	54.87	Hydrogen (H_2)	13.7
Ash	12.72	Methane (CH_4)	2.2
Sulphur	1.75	Nitrogen (N_2)	56.1
		Oxygen (O_2)	.1
		Ethylene (C_2H_4)	.4

WASHING TESTS.

Pennsylvania No. 17.

Test 189.—Duration of test, 1½ hours. Size as used, through 1-inch screen. Jig used, special; speed, 70 r. p. m.; stroke, 2½ inches. Raw coal, 7.28 tons; washed coal, 6.30 tons, 87 per cent; refuse, 0.98 ton, 13 per cent.

Analyses.

Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur.	
			Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
Raw coal, car sample	4421	4.35	11.90		1.51	
Washed coal, test 189	4598	5.18	8.02	33	1.16	23
Refuse		4.58	41.50		8.85	

Float and sink tests.

No. of test.	Size used (inch).	Specific gravity of solution used.	Percentage of float.		Sink (per cent).	Analyses.			
			To refuse.	To total sample.		Ash.		Sulphur.	
						Per cent.	Per cent. reduction.	Per cent.	Per cent. reduction.
On raw coal (preliminary):									
1	¾	1.35		86	14	5.14	57	1.00	34
2	¾	1.40		90	10	5.69	52	1.08	28
3	¾	1.45		91	9	6.20	48	1.26	17
4	¾	1.52		91	9	7.51	37	1.13	25
On refuse (float): [a]									
1		1.35	13.00	1.70		5.39		1.28	
2		1.41	14.00	1.80		6.20		1.40	
3		1.45	19.30	2.60		8.15		1.47	
4		1.51	23.75	3.20		9.51		1.67	

[a] Loss of good coal as calculated, 1.5 per cent. By "good coal" is meant all coal of a quality equal to or better than that of the washed coal.

COKING TESTS.

Pennsylvania No. 17 (run of mine).

		Test 178 (raw).	Test 186 (w.).
Size as used		f. c.	f. c.
Duration of test	hours.	52	44
Coal charged	pounds.	12,220	11,920
Coke produced	do.	7,923	7,523
	per cent.	64.94	63.11
Breeze produced	pounds.	356	307
	per cent.	2.92	2.58
Total yield	do.	67.86	65.69

Remarks.—Test 178: Light-gray and silvery; good weight coke; ash high. Test 186: Good, strong, heavy coke; light-gray and silvery. Washing improves both physical appearance and chemical analysis, reducing ash and sulphur.

Analyses.

	Test 178.		Test 186.	
	Coal.	Coke.	Coal.	Coke.
Moisture	4.41	0.22	6.30	0.29
Volatile matter	28.83	.36	28.24	.56
Fixed carbon	57.86	84.55	57.22	87.96
Ash	8.90	14.87	8.24	11.19
Sulphur	1.39	1.37	1.19	1.00

PENNSYLVANIA NO. 18.

Bituminous coal from a mine working the "Miller" bed, outcropping at Lloydell, Cambria County, on the Pennsylvania Railroad, was designated Pennsylvania No. 18.

This sample consisted of run-of-mine coal shipped under the supervision of K. M. Way, and was used in steaming tests 499 and 515 (on briquets); briquetting tests 196*, 197*, 200*, 201, 202, 205, 232*†, 236†, and 250†; mixed with Rhode Island No. 1 in briquetting test 243†; and mixed with Miscellaneous No. 9 in briquetting tests 238†, 239†, 240†, and 248. Four cars were shipped to the plant, and one car was shipped to the Pennsylvania Railroad locomotive-testing plant at Altoona.

Two mine samples were taken for chemical analysis. Sample 4347 was cut from the left entry, 2,500 feet south of the mouth of the drift. Sample 4348 was taken from the face of the fifth left entry, 3,200 feet south of the mouth of the drift.

Six car samples were taken—sample 4509 for complete chemical analysis, and five others for air-drying loss and moisture, as follows:

Laboratory No.	4490	4514	4547	4505	4499
Air-drying loss	8.10	3.80	4.40	6.20	4.60
Moisture	8.72	4.32	5.01	6.60	5.14

CHEMICAL ANALYSES.

Pennsylvania No. 18.

	Mine samples.		Car sample.	Steaming tests.[a]	
				499.	515.
Laboratory No.	4347	4348	4509	1512	4755
Air-drying loss	1.90	2.20	4.10		
Proximate:					
Moisture	2.43	2.66	4.46	4.05	5.95
Volatile matter	17.75	17.60	15.44	19.68	18.41
Fixed carbon	73.21	71.18	71.63	66.56	67.00
Ash	6.61	8.56	8.47	9.71	8.64
Sulphur	1.34	2.97	1.49	1.72	1.34
Ultimate:					
Hydrogen			4.80	4.29	4.16
Carbon			77.43	79.76	80.41
Nitrogen			11.28	1.05	1.19
Oxygen			6.53	2.99	3.63
Ash				10.12	9.19
Sulphur				1.79	1.42
Calorific value determined (as received) calories		7,775	7,601		
Calorific value determined (as received) B. t. u.		13,995	13,682		

	Briquetting tests.[b]								
	196*.	200*.	232*†,205.	236†.	238†.	239†.	240†.	243†.	250†.
Proximate:									
Moisture	3.25	3.01	2.41	4.71	1.83	1.30	1.06	1.34	2.55
Volatile matter	18.17	17.84	19.41	18.43	15.05	13.73	15.87	16.39	24.23
Fixed carbon	69.87	70.53	68.86	69.14	69.52	69.67	69.24	70.34	62.80
Ash	8.71	8.62	9.32	7.72	13.60	13.50	13.83	11.93	10.42
Sulphur	1.42	1.38	1.75	1.19	1.61	1.19	1.44	1.37	1.99
Ultimate:									
Hydrogen	4.12	4.13	4.10	4.40	3.12	2.81	2.81	3.46	4.36
Carbon	81.41	82.27	81.20	81.77	77.24	70.94	76.02	77.79	78.64
Nitrogen	1.19	1.27	1.11	1.26	.70	.75	.81	.53	.88
Oxygen	2.81	2.02	2.25	3.22	3.48	8.79	4.92	4.74	3.39
Ash	9.00	8.89	9.55	8.10	13.82	15.50	13.98	12.09	10.69
Sulphur	1.47	1.42	1.79	1.25	1.64	1.21	1.46	1.39	2.04

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Pennsylvania No. 18 (briquets).

	Test 499.	Test 515.
Duration of test.....hours..	8.58	9.22
Heating value of fuel.....B. t. u. per pound dry fuel..	14,119	14,292
Force of draft:		
Under stack damper.....inch water..	0.81	0.84
Above fire.....do....	.19	.18
Furnace temperature.....°F..	2,854	2,709
Dry fuel used per square foot of grate surface per hour.....pounds..	21.50	21.13
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	4.09	4.02
Percentage of rated horsepower of boiler developed.....	114.7	112.6
Water apparently evaporated per pound of fuel as fired.....pounds..	7.54	7.38
Water evaporated from and at 212°F.:		
Per pound of fuel as fired.....do....	9.14	8.95
Per pound of dry fuel.....do....	9.52	9.52
Per pound of combustible.....do....	10.72	10.62
Efficiency of boiler, including grate.....per cent..	65.11	64.33
Fuel as fired:		
Per indicated horsepower hour.....pounds..	3.09	3.16
Per electrical horsepower hour.....do....	3.82	3.90
Dry fuel:		
Per indicated horsepower hour.....do....	2.97	2.97
Per electrical horsepower hour.....do....	3.66	3.67

Remarks.—Test 499 on Renfrow briquets from tests 201 and 202; test 515 on English briquets from test 197*. English briquets fired whole, both burned with short flame, intense white heat, and no smoke. English briquets made 26 per cent clinker; Renfrow briquets made 44 per cent clinker.

BRIQUETTING TESTS.

Pennsylvania No. 18 (run of mine).

Tests 196, 197*, 200*, 201, 202, 205, 232*, 236†, and 250†.*—Size as used: Over $\frac{1}{4}$ inch, 1.4 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 5 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 10.6 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 24.8 per cent; through $\frac{1}{40}$ inch, 58.2 per cent. Excellent briquets were made with 5, 6, and 7 per cent binder on the English machine; 8 per cent binder gave good results on the Renfrow machine, but those with 6 and 7 per cent binder were not satisfactory. This coal worked equally well with high and low moisture content, making briquets with hard surfaces that were easily handled and piled. The fracture was smooth, the particles of coal being so thoroughly cemented that the appearance was like a solid mass. For analyses of briquets see page 210 (briquets from tests 201 and 202 under "Steaming test 499," from test 197* under "Steaming test 515").

	Test 196*.	Test 197*.	Test 200*.	Test 201.	Test 202.	Test 205.	Test 232*†.	Test 236†.	Test 250†.
Details of manufacture:									
Machine used.....	Eng.	Eng.	Eng.	Renf.	Renf.	Renf.	Renf.	Eng.	English
Temperature of briquets.....°F..	158	140	185	149	149	158	167	158	157
Binder—									
Kind.....	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	(a)
Laboratory No. (see p. 40).	4683	4683	4683	4683	4683	4806	4806	4806	4825
Amount, per cent..	6	7	5	6	7	8	8	7	8
Weight of—									
Fuel briquetted, pounds.....	24,000	128,000	24,000	3,600	6,500	6,000	146,000	40,000	1,800
Briquets, average, pounds.....	3.57	3.62	3.66	0.456	0.439	0.407	0.469	3.62	3.91
Heat value per pound—									
Fuel as received, B. t. u.....	13,682	13,682	13,682	13,682	13,682	13,682	13,682	13,682	13,682
Fuel as fired, B. t. u.....	14,029	13,442	13,946	13,547	13,547	13,937	13,937	13,873	13,680
Binder....B. t. u..	16,637	16,637	16,637	16,637	16,637	16,637	16,864	16,864	17,156

a Wax tailings.

BRIQUETTING TESTS—Continued.

Pennsylvania No. 18 (run of mine).

	Test 196*.	Test 197*.	Test 200*.	Test 201.	Test 202.	Test 205.	Test 232*†.	Test 236†.	Test 250†.
Drop test (1-inch screen):									
Held.....per cent..	70.6	66.7	62.5	21.0	41.0	54.5	54.5	67.5	89.0
Passed.....do....	29.4	33.3	37.5	79.0	59.0	45.5	45.5	32.5	11.0
Tumbler test (1-in. screen):									
Held.....per cent..	66.0	66.1	72.2	51.0	71.0	85.0	89.5	61.8	91.9
Passed (fines)...do....	34.0	33.9	27.8	49.0	29.0	15.0	10.5	38.2	8.1
Fines through 10-mesh sieve.....per cent..	76.0	59.5	77.6	89.7	89.2	89.7	90.3	53.4	46.2
Weathering test:									
Time exposed...days..	1	.....	.....	.....	.....	.....	.....	.....	.....
Condition.....	A.	.....	.....	.....	.....	.....	.....	.....	.....
Water absorption:									
In 19 days...per cent..	14.9	12.0	.....	.....	.....	.....	.....	.....	.....
In 13 days.....do....	.....	.....	11.5	17.4	16.0	15.3	11.0	11.7	5.9
Average for first 4 days, per cent.....	1.85	1.55	2.10	3.12	2.88	2.33	1.83	2.13	0.95
Specific gravity (apparent).	1.129	1.161	1.131	1.088	1.106	1.102	1.164	1.156	1.240

Extraction analyses.[a]

	Fuel.	Briquets.						
		Test 196*.	Test 197*.	Test 200*.	Tests 201, 202.	Tests 205, 232*†.	Test 236†.	Test 250†.
Laboratory No.....	4490	5061	4755	5052	4512	5049	4797	4906
Air-drying loss.....per cent..	8.10	.....	5.10	.....	3.90	.....	3.80	1.70
Extracted by CS_2:								
Air-dried.....do....	.76	.....	5.91	.....	5.96	.....	7.69	8.10
As received.....do....	.69	5.44	5.61	4.68	5.73	8.11	7.38	7.96
Pitch in briquets as received..do....	.....	5.36	5.56	4.51	5.70	7.78	6.98	7.33

[a] For extraction analyses of pitches used, see p. 40.

Test 238†.—Pennsylvania No. 18, 75 per cent; miscellaneous No. 9 (coke breeze), 25 per cent. Satisfactory briquets were made with 8 per cent binder; similar to briquets from Pennsylvania No. 18, alone. Surfaces smooth and hard; fractured surface smooth with sharp edges; could be handled easily while warm, and did not crush or stick together when piled warm.

Test 239†.—Equal parts of Pennsylvania No. 18 and miscellaneous No. 9. The briquets were softer when warm than in test 238†, but could be handled without breaking; very hard when cold; broke without crumbling; fractured surface rough but firm.

Test 240†.—Pennsylvania No. 18, 25 per cent; miscellaneous No. 9, 75 per cent. The briquets were very soft when warm and could not be handled without considerable breakage, but hard when cold; fractured surface very rough, with edges that crumbled easily. This test showed the necessity of handling fuel mechanically until cold to prevent breakage.

Test 243†.—Equal parts of Pennsylvania No. 18 and Rhode Island No. 1, both run of mine. An effort was made to improve the burning qualities by increasing the melting point of the binder, but owing to the hardness of the pitch used and insufficient pressure, these briquets were not satisfactory. They could not be handled when warm without many being broken, but when cold were brittle, producing considerable slack in handling. No physical tests were made.

Test 248.—Pennsylvania No. 18, 10 per cent; miscellaneous No. 9, 90 per cent. Characteristics of briquets noted in test 240† were more pronounced. The breakage of warm briquets in falling from machine and during handling with coke fork was

fully 50 per cent, showing the necessity of careful handling of briquets on a belt conveyor until they are cool. The cold briquets were handled satisfactorily.

For analyses of briquets, see page 210.

	Test 238†.	Test 239†.	Test 240†.	Test 243†.	Test 248.
Size as used:					
Over ¼ inch....per cent..	1.0	0.6	1.4	1.0	1.4
⅛ inch to ¼ inch....do....	6.8	6.2	7.8	6.8	8.4
1/16 inch to ⅛ inch....do....	14.2	15.0	16.6	17.6	16.8
1/32 inch to 1/16 inch....do....	21.8	23.4	26.2	25.2	29.0
Under 1/32 inch....do....	56.2	54.8	48.0	49.4	44.4
Details of manufacture:					
Machine used....	Renf.	Renf.	Renf.	Renf.	Renf.
Temperature of briquets....°F..	167	167	167	185	158
Binder—					
Kind....	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)....	4806	4806	4806	4625	4879
Amount....per cent..	8.0	8.0	8.0	8.0	8.0
Weight of—					
Fuel briquetted....pounds..	10,000	8,000	8,000	2,000	2,000
Briquets, average....do....	0.485	0.479	0.568	.....	0.479
Heat value per pound—					
Fuel as received—Pa. No. 18....B. t. u..	13,682	13,682	13,682	13,682	13,682
Fuel as received—R. I. No. 1....do....	.....	.....	.....	10,996	.....
Fuel as received—Misc. No. 9....do....	10,870	10,870	10,870	.....	10,870
Fuel as fired....do....	13,185	12,787	12,721	13,387	.....
Binder....	16,864	16,864	16,864	16,576	16,805
Drop test (1-inch screen):					
Held....per cent..	48.0	56.5	40.0	.....	61.0
Passed....do....	52.0	43.5	60.0	.....	39.0
Tumbler test (1-inch screen):					
Held....do....	87.0	78.5	90.0	.....	80.0
Passed (fines)....do....	13.0	21.5	10.0	.....	20.0
Fines through 10-mesh sieve....do....	84.4	92.6	100.0	.....	85.2
Water absorption:					
In 23 days....do....	.....	.....	.....	.....	19.5
In 10 days....do....	.....	15.8	.....	.....	.....
In 9 days....do....	.....	.....	14.0	.....	.....
In 8 days....do....	13.9	.....	.....	.....	.....
Average for first—					
7 days....do....	.....	2.07	.....	.....	.....
5 days....do....	2.42	.....	2.4	.....	2.68
4 days....do....	.....	.....	.....	.....	.....
Specific gravity (apparent)....	1.165	1.177	1.280	.....	1.148

Extraction analyses.

	Pitches.		Fuels.			Briquets.			
			Pa. No. 18.	R. I. No. 1.	Misc. No. 9.	Test 238†.	Test 239†.	Test 240†.	Test 243†.
Laboratory No....	4625	4806	4490	3141	4763	4930	4932	4977	4832
Air-drying loss....per cent..	.....	.....	8.10	3.40	1.30	1.00	0.90	.....	0.70
Extracted by CS_2:									
Air-dried....do....	.....	.....	.76	.02	.15	7.21	7.55	.....	8.91
As received....do....	90.56	96.90	.69	.02	.15	7.21	7.52	7.43	8.84
Pitch in briquets as received....per cent..	.....	.....	.....	.....	.....	7.17	7.35	7.14	9.41

PENNSYLVANIA NO. 19.

Bituminous coal from the Pittsburg bed one-fourth mile north of Herminie, Westmoreland County, on the Pennsylvania Railroad, was designated Pennsylvania No. 19. The coal, as worked at a depth of 300 feet at this place, averages 6 feet 2¼ inches in thickness.

One sample, consisting of run-of-mine coal shipped under the supervision of A. K. Adams, was used in steaming tests 498 and 508 (on briquets), coking tests 176 and 177, and briquetting tests 218, 219, and 242.

Two mine samples were taken for chemical analysis. Sample 4351 was taken 1,400 feet north of the opening, where the coal measured 5 feet 8¾ inches in thickness. Sample 4352 was taken 4,000 feet south of the opening, where the coal measured 6 feet 7¾ inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 19.

	Mine samples.		Car sample.	Steaming tests.[a]		Briquetting test 242.[a]
				498.	508.	
Laboratory No.	4351	4352	4489	.....	4648	4828
Air-drying loss	1.70	1.00	2.40	.....	.....	0.50
Proximate:						
Moisture	2.81	2.01	3.39	3.20	5.12	1.75
Volatile matter	32.21	33.56	31.79	31.65	33.00	33.50
Fixed carbon	58.71	58.11	56.46	57.32	54.36	55.24
Ash	6.27	6.32	8.36	7.83	7.52	9.51
Sulphur	.99	1.39	1.05	1.51	1.05	1.36
Ultimate:						
Hydrogen	.....	.....	5.07	4.86	4.76	4.52
Carbon	.....	.....	74.42	77.11	77.93	75.91
Nitrogen	.....	.....	1.39	1.44	1.41	1.35
Oxygen	.....	.....	9.71	6.94	6.86	7.16
Ash	.....	.....	.....	8.09	7.93	9.69
Sulphur	.....	.....	.....	1.56	1.11	1.38
Calorific value determined (as received) { calories	.....	7,862	7,566	.....	.....	7,581
Calorific value determined (as received) { B. t. u.	.....	14,152	13,699	.....	.....	13,646

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Pennsylvania No. 19 (run of mine).

	Test 498.	Test 508.
Size as used:		
Over 1 inch, per cent	67.1	
½-inch to 1 inch, do	12.4	
¼-inch to ½-inch, do	7.8	See p. 215.
Under ¼-inch, do	12.7	
Average diameter, inches	1.99	
Duration of test, hours	9.50	9.38
Heating value of fuel, B. t. u. per pound of dry fuel	14,128	14,270
Force of draft:		
Under stack damper, inch water	0.86	0.97
Above fire, do	.19	.23
Furnace temperature, °F.	2,828	.....
Dry fuel used per square foot of grate surface per hour, pounds	20.42	20.96
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.81	4.05
Percentage of rated horsepower of boiler developed	106.8	113.7
Water apparently evaporated per pound of fuel as fired, pounds	7.48	7.58
Water evaporated from and at 212° F.:		
Per pound of fuel as fired, do	9.05	9.20
Per pound of dry fuel, do	9.35	9.69
Per pound of combustible, do	10.48	10.79
Efficiency of boiler, including grate, per cent	63.91	65.58
Fuel as fired:		
Per indicated horsepower hour, pounds	3.12	3.07
Per electrical horsepower hour, do	3.86	3.79
Dry fuel:		
Per indicated horsepower hour, do	3.02	2.92
Per electrical horsepower hour, do	3.73	3.60

Remarks.—Test 508 on briquets, equal parts from tests 218 and 219.

COKING TESTS.

Pennsylvania No. 19 (run of mine).

		Test 176.	Test 177.
Size as used		r. o. m.	f. c.
Duration of test	hours.	36	40
Coal charged	pounds.	12,110	12,100
Coke produced	do.	7,800	8,490
	per cent.	64.41	70.17
Breeze produced	pounds.	315	336
	per cent.	2.60	2.78
Total yield	do.	67.01	72.95

Remarks.—Test 176: Good heavy coke; light gray with a little silvery deposit of carbon. Brittleness probably due to unbroken pieces of slate. Test 177: Good heavy coke; light gray and silvery. Crushing improves physical properties of coke and increases yield. Breakage, good large uniform-sized pieces.

Analyses.

	Test 176.		Test 177.	
	Coal.	Coke.	Coal.	Coke.
Moisture	3.01	0.24	3.57	0.13
Volatile matter	30.66	.19	29.56	.49
Fixed carbon	57.17	88.06	59.17	87.45
Ash	9.16	11.51	7.70	11.93
Sulphur	1.16	.95	.98	.83

BRIQUETTING TESTS.

Pennsylvania No. 19 (run of mine).

Tests 218, 219, 242.—Size as used: Over ¼-inch, 3 per cent; $\frac{1}{10}$-inch to ¼-inch, 8.8 per cent; $\frac{1}{20}$-inch to $\frac{1}{10}$-inch, 17 per cent; $\frac{1}{40}$-inch to $\frac{1}{20}$-inch, 26.3 per cent; through $\frac{1}{40}$-inch, 47.6 per cent.

Briquets with 6, 7, and 8 per cent binder appeared equally satisfactory. Edges were sharp, surfaces hard and smooth, fracture clear with firm edges. Renfrow briquets had a glossy surface. All briquets handled and piled well. For analyses of briquets see page 214 (those from tests 218 and 219 under "Steaming test 508").

		Test 218.	Test 219.	Test 242.
Details of manufacture:				
Machine used		Eng.	Eng.	Renf.
Temperature of briquets	°F.	185	185	149
Binder—				
Kind		w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)		4683	4683	4806
Amount	per cent.	6	7	8
Weight of—				
Fuel briquetted	pounds.	8,000	4,000	4,000
Briquets, average	do.	3.65	3.74	0.431
Heat value per pound—				
Fuel as received	B. t. u.	13,699	13,699	13,699
Fuel as fired	do.	13,540	13,540	13,646
Binder	do.	16,637	16,637	16,864
Drop test (1-inch screen):				
Held	per cent.	73.8	78.5	78.5
Passed	do.	26.2	21.5	21.5
Tumbler test (1-inch screen):				
Held	do.	75.6	78.8	91.5
Passed (fines)	do.	24.4	21.2	8.5
Fines through 10-mesh sieve	do.	70.0	65.0	90.09
Water absorption:				
In 13 days	do.	8.6	8.4	.....
In 10 days	do.	.....	.....	7.9
Average or first 8 days	do.	1.0	1.0	1.0
Specific gravity (apparent)		1.124	1.133	1.125

Extraction analyses.

	Pitches.		Fuel.	Briquets.	
				Tests 218, 219.	Test 242.
Laboratory No.	4683	4806	4681	4648	4828
Air-drying loss.....per cent.			1.00	4.00	0.50
Extracted by CS_2:					
Air-dried.....do....			.75	6.04	9.75
As received.....do....	89.31	96.90	.74	5.80	9.16
Pitch in briquets, as received.....do....				5.71	8.21

PENNSYLVANIA NO. 20.

Bituminous coal from the Lower Kittanning or B bed, 1½ miles east of Seward, Westmoreland County, on the Pennsylvania Railroad, was designated Pennsylvania No. 20. This coal, as worked from the outcrop at this place, averages 3 feet 7 inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of run-of-mine coal, and was used in steaming tests (on briquets) 512 and 514; washing test 194; coking tests 179 and 182; and briquetting tests 198†, 208, 209, 212, 213†, 215, and 216.

Two mine samples were taken for chemical analysis. Sample 4349 was taken 1,850 feet south of the opening, where the coal measured 3 feet 9 inches in thickness. Sample 4350 was taken 1,050 feet southwest of the opening, where the coal measured 3 feet 5 inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 20.

	Mine samples.		Car sample.	Steaming tests. *a*		Briquetting tests. *b*	
				512.	514.	198†.	213†.
Laboratory No.	4349	4350	4517	4726	4713	4769	4885
Air-drying loss	2.30	2.00					
Proximate:							
Moisture	2.80	2.48	4.00	3.50	2.79	6.16	1.23
Volatile matter	17.92	17.87	15.89	19.98	21.11	19.23	20.58
Fixed carbon	71.32	70.41	69.57	67.71	67.79	64.38	67.74
Ash	7.96	9.24	10.54	8.81	8.31	10.23	10.45
Sulphur	2.29	3.03	2.85	1.59	1.91	2.68	2.98
Ultimate:							
Hydrogen				4.39	4.42	4.20	4.56
Carbon				81.06	80.25	78.12	79.21
Nitrogen				1.06	1.09	1.09	1.12
Oxygen				2.72	3.73	2.83	1.51
Ash				9.13	8.55	10.90	10.58
Sulphur				1.64	1.96	2.86	3.02
Calorific value determined (as received) calories		7,679	7,415				
Calorific value determined (as received) B. t. u.		13,822	13,347				

a Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
b Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Pennsylvania No. 20 (briquets).

	Test 512 (w.).	Test 514.
Duration of test.....hours..	7.77	7.93
Heating value of fuel.....B. t. u. per pound of dry fuel..	14,495	14,382
Force of draft:		
Under stack damper.....inch water..	0.93	0.93
Above fire.....do....	.19	.23
Dry fuel used per square foot of grate surface per hour.....pounds..	19.93	27.52
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	3.84	4.47
Percentage of rated horsepower of boiler developed.....	107.7	125.3
Water apparently evaporated per pound of fuel as fired.....pounds..	7.70	6.54
Water evaporated from and at 212 °F.:		
Per pound of fuel as fired.....do....	9.32	7.91
Per pound of dry fuel.....do....	9.65	8.14
Per pound of combustible.....do....	10.76	9.06
Efficiency of boiler, including grate.....per cent..	64.29	54.66
Fuel as fired:		
Per indicated horsepower hour.....pounds..	3.03	3.58
Per electrical horsepower hour.....do....	3.75	4.41
Dry fuel:		
Per indicated horsepower hour.....do....	2.93	3.47
Per electrical horsepower hour.....do....	3.62	4.29

Remarks.—Test 512 on briquets from tests 215 and 216 (equal weights); briquets burned freely, with intense heat and no smoke; 31 per cent clinker. Test 514 on briquets from tests 208 and 209 (equal weights); briquets burned freely, with intense heat and no smoke; 50 per cent clinker.

WASHING TESTS.

Pennsylvania No. 20.

Test 194.—Duration of test, 2¾ hours. Size as used, through 1-inch screen. Jig used, special; speed, 70 r. p. m.; stroke, 2½ inches. Raw coal, 22.21 tons; washed coal, 17.25 tons, 78 per cent; refuse, 4.96 tons, 22 per cent.

Analyses.

Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur.	
			Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
Raw coal, car sample.....	4517	4.00	10.54	.....	2.85	.....
Washed coal, test 194.....	4553	6.48	6.76	36	1.30	54
Refuse.....	.....	10.21	46.25	.....	17.40	.....

Float and sink tests.

Number of test.	Size used (inch).	Specific gravity of solution used.	Percentage of float.		Sink (per cent).	Analyses.			
			To refuse.	To total sample.		Ash.		Sulphur.	
						Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
On raw coal (preliminary):									
1.....	¾	1.35	.....	83	17	4.95	53	0.93	67
2.....	¾	1.42	.....	88	12	5.66	46	1.24	57
3.....	¾	1.45	.....	88	12	4.72	55	1.02	64
4.....	¾	1.52	.....	89	11	6.07	42	1.09	62
On refuse (float): [a]									
1.....	.....	1.35	17.20	3.91	.....	5.42	.....	1.69	.....
2.....	.....	1.41	18.50	4.20	.....	5.69	.....	1.69	.....
3.....	.....	1.45	19.88	4.51	.....	6.45	.....	2.15	.....
4.....	.....	1.53	20.20	4.59	.....	7.89	.....	2.08	.....

[a] Figures indicate that finer crushing is advantageous. Loss of "good coal" in the refuse will not exceed 2 per cent. By "good coal" is meant all coal of a quality equal to or better than that of the washed coal.

COKING TESTS.

Pennsylvania No. 20 (run of mine).

	Test 179 (raw).	Test 182 (w.).
Size as used	f. c.	f. c.
Duration of test, hours	68	78
Coal charged, pounds	13,070	11,760
Coke produced, do	8,129	7,350
Coke produced, per cent	62.20	62.50
Breeze produced, pounds	420	529
Breeze produced, per cent	3.21	4.50
Total yield, do	65.41	67.00

Remarks.—Test 179: Light-gray and silvery color; soft, dense coke; high ash and sulphur. Test 182: Gray color; soft, dense coke; ash and sulphur reduced by washing; no improvement in physical appearance.

Analyses.

	Test 179.		Test 182.	
	Coal.	Coke.	Coal.	Coke.
Moisture	3.91	0.30	6.30	0.51
Volatile matter	16.35	.28	17.04	.58
Fixed carbon	68.30	84.95	69.58	89.85
Ash	11.44	14.47	7.08	9.06
Sulphur	2.78	2.31	1.34	1.11

BRIQUETTING TESTS.

Pennsylvania No. 20 (run of mine).

Tests 198, 208, and 209.—Size as used: Over $\frac{1}{4}$ inch, 0.8 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 3.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 11.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 27.0 per cent; through $\frac{1}{40}$ inch, 57.4 per cent. Briquets from both machines had similar appearance, with smooth, hard surface; were very brittle, and broke with a glossy fracture and sharp edges. The percentage of binder seemed to have little effect on brittleness, although Renfrow briquets, with 8 per cent binder, handled with less breakage.

Tests 212, 213†, 215, and 216 (on washed coal).—Size as used: Over $\frac{1}{4}$ inch, 0.8 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 4.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 16.0 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 26.0 per cent; through $\frac{1}{40}$ inch, 52,4 per cent. There was no noticeable difference between these briquets and those made from raw coal.

For analyses of briquets see page 216 (those from tests 208 and 209 under "Steaming test 514;" from tests 212, 215, and 216 under "Steaming test 512").

	Test 198†.	Test 208.	Test 209.	Test 212.	Test 213†.	Test 215.	Test 216.
Details of manufacture:							
Machine used	Eng.	Renf.	Renf.	Renf.	Renf.	Eng.	Eng.
Temperature of briquets	158	158	158	158	158	176	176
Binder—							
Kind	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4683	4683	4683	4683	4683	4683	4683
Amount, per cent	6	7	8	7	8	6	7
Weight of—							
Fuel briquetted, pounds	3,200	4,500	8,000	6,500	6,500	6,400	3,300
Briquets, average, do	3.52	0.451	0.457	0.427	0.458	3.63	3.44
Heat value per pound—							
Fuel as received, B. t. u.	13,347	13,347	13,347	14,639	14,639	14,639	14,639
Fuel as fired, do	13,198	13,981	13,981	.....	13,896	13,988	13,988
Binder, do	16,637	16,637	16,637	16,637	16,637	16,637	16,637
Drop test (1-inch screen):							
Held, per cent	74.8	19.5	26.0	23.0	19.5	74.6	71.9
Passed, do	25.2	80.5	74.0	77.0	80.5	25.4	28.1

BRIQUETTING TESTS—Continued.

Pennsylvania No. 20 (run of mine).

	Test 198†.	Test 208.	Test 209.	Test 212.	Test 213†.	Test 215.	Test 216.
Tumbler test (1-inch screen):							
Held.....per cent..	71.0	54.0	61.5	67.0	64.0	74.0	70.5
Passed (fines).....do....	29.0	46.0	38.5	33.0	36.0	26.0	29.5
Fines through 10-mesh sieve.....do....	65.4	86.8	86.4	91.6	87.3	63.2	70.4
Water absorption:							
In 13 days.....do....	14.5	15.5	15.0	19.0	14.5	9.5	11.0
Average for first 5 days.....do....	2.34	2.78	2.66	3.1	2.50	1.56	1.56
Specific gravity (apparent).....	1.141	1.11	1.127	1.043	1.144	1.148	1.121

Extraction analyses.

	Pitch.	Fuel.	Briquets.			
			Test 198†.	Tests 208, 209.	Test 213†.	Tests 215, 216.
Laboratory No.....	4683	4498	4769	4713	4885	4726
Air-drying loss.....per cent..	.....	3.10	5.50	2.00	0.60	3.10
Extracted by CS_2:						
Air-dried.....do....	.....	1.02	5.60	6.86	8.03	6.90
As received.....do....	89.31	.99	5.29	6.72	7.98	6.61
Pitch in briquets as received.....do....	.....	.....	5.00	6.49	7.92	6.37

PENNSYLVANIA NO. 21.

Bituminous coal from the Pittsburg bed, 2 miles southwest of Connellsville, Fayette County, on the Pennsylvania Railroad, was designated Pennsylvania No. 21. The coal, as worked at a depth of 315 feet at this place, averages 7 feet 6¼ inches in thickness.

One sample, shipped under the supervision of A. K. Adams, consisted of run-of-mine coal, and was used in coking tests 183, 187, 189, 191, and 192, and cupola test 190.

Two mine samples were taken for chemical analysis. Sample 4411 was taken 6,500 feet northwest of the opening, where the coal measured 7 feet 5½ inches in thickness. Sample 4412 was taken 9,000 feet northwest of the opening, where the coal measured 7 feet 8 inches in thickness.

CHEMICAL ANALYSES.

Pennsylvania No. 21.

	Mine samples.		Car sample.		Mine samples.		Car sample.
Laboratory No.....	4412	4411	4609	Ultimate:			
Air-drying loss.....	1.80	1.40	4.20	Hydrogen.....	.....	.....	4.91
Proximate:				Carbon.....	.....	.....	73.13
Moisture.....	2.82	2.40	5.13	Nitrogen.....	.....	.....	1.50
Volatile matter.....	29.97	29.90	27.87	Oxygen.....	.....	.....	10.89
Fixed carbon.....	59.84	60.48	58.29	Calorific value determined (as received) calories..	7,773	.....	7,525
Ash.....	7.37	7.22	8.71	Calorific value determined (as received) B. t. u...	13,991	.....	13,365
Sulphur.....	1.22	.97	.86				

COKING TESTS.

Pennsylvania No. 21 (run of mine).

	Test 183.	Test 187.	Test 189.	Test 191.	Test 192.
Size as used	Not crushed.	f. c.	Not crushed.	Through 1-inch screen.	Through ¾-inch screen.
Duration of test, hours	70	78	51	47	43
Coal charged, pounds	15,140	14,360	12,450	11,940	11,500
Coke produced, do	10,200	9,982	8,457	7,963	7,733
Coke produced, per cent	67.37	69.51	67.93	66.69	67.24
Breeze produced, pounds	401	326	319	368	339
Breeze produced, per cent	2.65	2.27	2.56	3.08	2.95
Total yield, do	70.02	71.78	78.49	69.77	70.19

Remarks.—Light gray and silvery; good heavy coke.

Analyses.

	Test 183.		Test 187.		Test 189.		Test 191.		Test 192.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	5.37	0.71	5.53	0.63	4.05	0.82	4.28	0.33	3.58	0.29
Volatile matter	28.33	.12	27.97	.66	29.26	.21	29.92	.15	28.86	.69
Fixed carbon	59.07	88.24	57.81	87.78	58.29	88.22	58.22	88.54	60.13	88.54
Ash	8.23	10.93	8.69	10.93	8.40	10.75	7.58	10.98	7.43	10.48
Sulphur	.89	.82	.86	.62	.93	.81	.95	.87	.91	.76

Cupola test of coke made from Pennsylvania No. 21 coal.

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
					Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
190	187	1.90	7	Coke	210	55	55	55	55	430
				Pig iron	630	405	405	405	405	2,250
				Scrap	210	135	135	135	135	750

[a] Sulphur in ash, 0.0115 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Maximum.	Iron running in—	Weight of iron. Poured.	Additional melted.	Total.	Melting. Time.	Rate per hour.	Ratio iron to coke.	Loss.	Recovered. Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
190	11.00 a. m.	7	6	1,793	691	2,484	25	5,962	7.31	10.16	211	90

LADLE RECORD.

Ladle No.	Pounds.	Time (a. m.).	Ladle No.	Pounds.	Time (a. m.).
1	61	11.10	13	52	11.25
2	132	11.13	14	72	11.25½
3	80	11.15	15	30	11.26
4	62	11.17	16	89	11.26½
5	147	11.17½	17	132	11.28
6	55	11.18	18	64	11.28½
7	49	11.20	19	44	11.29
8	136	11.20½	20	28	11.29½
9	73	11.21	21	100	11.38
10	52	11.22	22	23	11.38½
11	125	11.22½	23	87	11.39
12	83	11.23	24	17	11.39

Remarks.—Test 190: Temperature of iron, medium. Blast off 8 minutes.

PENNSYLVANIA NO. 22.

Bituminous coal from the Pittsburg bed at Huff, Westmoreland County, on the Pennsylvania Railroad, was designated Pennsylvania No. 22.

One sample of this coal, which is worked from the outcrop at this place, shipped under the supervision of John W. Groves, consisted of run-of-mine coal and was used in steaming test 510 (on briquets), producer-gas test 159, and briquetting tests 211†, 222, and 223†. No mine samples covering this shipment were taken.

CHEMICAL ANALYSES.

Pennsylvania No. 22.

	Car sample.	Steaming test 510.[a]	Briquetting tests.[b]	
			211†.	223†.
Laboratory No.	4498	4704	4684	4706
Air-drying loss	3.10			
Proximate:				
Moisture	3.98	5.15	2.21	3.55
Volatile matter	28.13	29.60	32.11	30.57
Fixed carbon	57.73	55.08	55.12	54.27
Ash	10.16	10.17	10.56	11.61
Sulphur	1.00	1.17	1.13	1.07
Ultimate:				
Hydrogen	4.96	4.46	4.53	3.55
Carbon	73.34	75.40	75.71	75.94
Nitrogen	1.53	1.39	1.39	1.24
Oxygen	9.01	6.80	6.41	6.12
Ash		10.72	10.80	12.04
Sulphur		1.23	1.16	1.11
Calorific value determined (as received) calories	7,395			
Calorific value determined (as received) B. t. u.	13,311			

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TEST.

Pennsylvania No. 22 (English briquets).

	Test 510.
Duration of test ..... hours	9.17
Heating value of fuel ..... B. t. u. per pound dry coal	13,900
Force of draft:	
Under stack damper ..... inch water	0.86
Above fire ..... do	.08
In ash pit (forced draft)	.46
Dry fuel used per square foot of grate surface per hour ..... pounds	19.63
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	3.50
Percentage of rated horsepower of boiler developed ..... do	98.1
Water apparently evaporated per pound of fuel as fired ..... pounds	6.99
Water evaporated from and at 212° F.:	
Per pound of fuel as fired ..... do	8.46
Per pound of dry fuel ..... do	8.92
Per pound of combustible ..... do	10.33
Efficiency of boiler, including grate ..... per cent	61.97
Fuel as fired:	
Per indicated horsepower hour ..... pounds	3.34
Per electrical horsepower hour ..... do	4.13
Dry fuel:	
Per indicated horsepower hour ..... do	3.17
Per electrical horsepower hour ..... do	3.91

Remarks.—Test made on briquets from tests 222 and 223† (equal weights); fuel burned freely with intense heat and no smoke; 47 per cent clinker.

PRODUCER-GAS TEST.

Pennsylvania No. 22 (run of mine).

Test 159.—Duration of test, 50 hours. Average electrical horsepower, 197.7. Average B. t. u. per cubic foot of gas, 145.6. Total coal fired, 11,700 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower-hour (pounds).			
Per electrical horsepower:			
Commercially available	1.23	1.18	1.06
Developed at switchboard	1.18	1.14	1.02
Per brake horsepower:			
Commercially available	1.05	1.00	.90
Developed at engine	1.01	.97	.86
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.31	1.26	1.12
Developed at switchboard	1.26	1.21	1.08
Per brake horsepower:			
Commercially available	1.11	1.07	.95
Developed at engine	1.07	1.03	.92

Analysis of gas by volume. [a]

Carbon dioxide (CO_2)	10.1
Carbon monoxide (CO)	17.6
Hydrogen (H_2)	13.3
Methane (CH_4)	2.2
Nitrogen (N_2)	56.4
Ethylene (C_2H_4)	.4

BRIQUETTING TESTS.

Pennsylvania No. 22 (run of mine).

Tests 211†, 222, and 223†.—Size as used: Over $\frac{1}{4}$ inch, 1.6 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 17.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 33.4 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 23.2 per cent; through $\frac{1}{40}$ inch, 24 per cent. English briquets with 7 per cent binder showed better outer surface than those with 6 per cent binder. In all briquets surfaces were hard, clean, sharp, and glossy, with characteristic fracture. Renfrow briquets dropped from belt without breakage.

For analyses of briquets see page 221 (those from test 222 under "Steaming test 510").

	Test 211†.	Test 222.	Test 223†.
Details of manufacture:			
Machine used	Renf.	Eng.	Eng.
Temperature of briquets °F.	158	185	158
Binder—			
Kind	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	4683	4683	4683
Amount per cent.	7	7	6
Weight of—			
Fuel briquetted pounds.	4,000	19,000	3,200
Briquets, average do.	0.442	3.87	3.93
Heat value per pound—			
Fuel as received B. t. u.	13,311	13,311	13,311
Fuel as fired do.	13,561	13,183	13,275
Binder do.	16,637	16,637	16,637
Drop test (1-inch screen):			
Held per cent.	54.5	79.8	62.2
Passed do.	45.5	20.2	37.8
Tumbler test (1-inch screen):			
Held do.	85.0	73.7	67.8
Passed (fines) do.	15.0	26.3	32.2
Fines through 10-mesh sieve do.	90.8	65.0	70.0
Water absorption:			
In 13 days do.	11.7	9.6	8.9
Average for first 5 days do.	1.78	1.48	1.38
Specific gravity (apparent)	1.110	1.160	1.164

[a] For analyses of fuel used see p. 221 (sample 4498).

Extraction analyses.

	Pitch.	Fuel.	Briquets.		
			Test 211†.	Test 222.	Test 223†.
Labratory No	4683	4650	4684	4704	4706
Air-drying loss, per cent		0.90	1.10	4.00	2.30
Extracted by CS_2:					
Air-dried, do		.77	6.85		6.35
As received, do	89.31	.76	6.77	5.45	6.20
Pitch in briquets as received, do			6.78	5.30	6.09

RHODE ISLAND.

RHODE ISLAND NO. 1.

Anthracite graphitic coal from Cranston, Providence County (near Providence), was designated Rhode Island No. 1. This sample was mined from surface workings at Cranston, and commercially would be classed as run-of-mine coal. It was shipped under the inspection of J. S. Burrows, and was used in making steaming test 401; also mixed with Utah No. 1 in steaming tests (on briquets) 414 and 415, coking tests 141 and 157 (see p. 263), and briquetting test 127 (see p. 264); mixed with Utah No. 2 in steaming test 416 (on briquets) and briquetting test 133 (see p. 266); mixed with Pennsylvania No. 15 in briquetting test 184† (see p. 204); and mixed with Pennsylvania No. 18 in briquetting test 243† (see pp. 212, 213).

CHEMICAL ANALYSES.

Rhode Island No. 1.

	Car sample.[a]	Steaming tests.[b]			
		401.	414.	415.	416.
Laboratory No	3216				
Air-drying loss	2.00				
Proximate:					
Moisture	2.41	2.33	2.45	2.27	5.85
Volatile matter	4.92	2.47	24.21	22.20	25.20
Fixed carbon	73.61	78.72	62.60	65.29	59.56
Ash	19.06	16.48	10.74	10.24	9.39
Sulphur	.07	.08	.41	.41	.85
Ultimate:					
Hydrogen	.90	.67	2.95	3.13	2.94
Carbon	75.10	79.49	78.63	77.64	76.42
Nitrogen	.17	.18	.74	.74	.73
Oxygen	4.70	2.71	6.25	7.59	9.04
Ash		16.87	11.01	10.48	9.97
Sulphur		.08	.42	.42	.90
Calorific value (as received):					
Determined, calories	6,109				
Determined, B. t. u.	10,996				
Calculated from ultimate analysis, calories	6,176				
Calculated from ultimate analysis, B. t. u.	11,117				

[a] Sample from producer-gas test 113 (failure) treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Rhode Island No. 1 (briquets).

	Test 401.	Test 414.	Test 415.	Test 416.
Duration of test.....hours..	8.05	5.0	5.0	10.02
Heating value of fuel.....B. t. u. per pound dry fuel..	11,639	12,845	12,823	12,244
Force of draft:				
Under stack damper.....inch water..	0.54	0.67	0.62	0.58
Above fire.....do....	.18	.21	.06	.20
Furnace temperature.....°F..	(a)	.....	2,119	2,053
Dry fuel used per square foot of grate surface per hour.....pounds..	20.22	18.42	19.01	21.51
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	1.99	2.96	3.25	2.78
Percentage of rated horsepower of boiler developed.....	55.8	83.0	91.0	78.0
Water apparently evaporated per pound of fuel as fired.....pounds..	4.19	6.75	7.17	4.26
Water evaporated from and at 212 °F.:				
Per pound of fuel as fired.....do....	4.81	7.86	8.36	4.95
Per pound of dry fuel.....do....	4.93	8.05	8.55	5.26
Per pound of combustible.....do....	7.70	9.35	9.75	7.70
Efficiency of boiler, including grate.....per cent..	40.9b	60.52	64.39	41.49
Fuel as fired:				
Per indicated horsepower hour.....pounds..	5.88	3.60	3.38	5.71
Per electrical horsepower hour.....do....	7.26	4.44	4.18	7.05
Dry fuel:				
Per indicated horsepower hour.....do....	5.74	3.51	3.31	5.38
Per electrical horsepower hour.....do....	7.08	4.34	4.08	6.64

a Too low to be read with Wanner optical pyrometer. Forced draft used on this test.

Remarks.—Tests 414 and 415 on briquets made from Rhode Island No. 1 and Utah No. 1, mixed. (See p. 264.) The briquets burned freely, with short yellow flame; did not crack open, but coked throughout and held together well. No smoke; burned very much like anthracite except for color of flame. These comparative tests on Rhode Island No. 1 coal gave only 55.8 per cent capacity and were unsatisfactory. (See test 401 above.) Heavy clinker, which was tough and plastic when hot and brittle when cold, but did not stick to the grate.

Test 416 on briquets from test 133 made from Rhode Island No. 1 and Utah No. 2, mixed. (See p. 266.) With natural draft the briquets burned with a very short flame; with forced draft they burned with a longer flame, giving a hotter fire. Briquets did not coke or hold together well in the fire. No smoke; see briquetting test 127 (p. 264) for comparative data. No clinker; a large amount of ash resulted, due to the crumbling of the briquets and the falling of the loose particles through the grate.

TENNESSEE.

TENNESSEE NO. 1.

Bituminous coal from Fork Ridge, Claiborne County, on the Louisville and Nashville Railroad, was designated Tennessee No. 1. The coal, as worked at a depth of 52 feet at this place, averages 4 feet 3 inches in thickness.

This sample consisted of run-of-mine coal, was shipped under the supervision of W. J. Von Borries, and was used in making steaming tests 344, 345, and 346; also steaming tests 409 and 411 on briquets made from washed coal; producer-gas test 115; washing test 171; coking tests 133 (raw) and 153 (washed); cupola tests 99, 126, and 128; and briquetting test 130 (washed coal).

Two mine samples were taken for chemical analysis. Sample 2907 was taken 4,000 feet northeast of the slope, where the coal measured 4 feet 4 inches in thickness. Sample 2908 was taken 4,400 feet east of the slope, where the coal measured 4 feet 3 inches in thickness.

CHEMICAL ANALYSES.

Tennessee No. 1.

	Mine samples.		Car sample.[a]	Steaming tests.[b]				
				344.	345.	346.	409.	411.
Laboratory No	2907	2908	3016					
Air-drying loss	1.80	1.80	3.00					
Proximate:								
Moisture	3.71	3.66	4.81	4.81	4.06	4.20	2.62	1.99
Volatile matter	35.61	34.58	32.91	32.91	33.80	31.75	37.09	36.56
Fixed carbon	55.94	54.93	51.13	51.13	50.97	50.02	54.32	54.14
Ash	4.74	6.83	11.15	11.15	11.17	14.03	5.97	7.30
Sulphur	1.28	.99	1.58	1.58	1.67	1.45	1.17	1.12
Ultimate:								
Hydrogen			5.13	4.83	4.84	4.68	5.08	4.84
Carbon			69.22	72.72	72.71	70.37	79.02	77.39
Nitrogen			1.60	1.68	1.68	1.63	1.70	1.53
Oxygen			11.32	7.40	7.39	7.17	6.87	7.64
Ash				11.71	11.64	14.64	6.13	7.46
Sulphur				1.66	1.74	1.51	1.20	1.14
Calorific value (as received):								
Determined, calories	7,669		6,983					
Determined, B. t. u.	13,804		12,569					
Calculated from ultimate analysis, calories			6,907					
Calculated from ultimate analysis, B. t. u.			12,433					

[a] Sample from steaming test 344 treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Tennessee No. 1 (run of mine).

	Test 344.	Test 345.	Test 346.	Test 409.	Test 411.
Size as used:					
Over 3 inches, per cent	38.2	40.8			
Over 2 inches, do			43.8		
Over 1 inch, do	24.5	17.1	27.2	See p. 228	See p. 228
½ inch to 1 inch, do	14.7	19.1	12.4		
¼ inch to ½ inch, do	8.8	9.8	7.4		
Under ¼ inch, do	13.8	13.2	9.2		
Duration of test, hours	10.0	7.28	7.03	10.08	4.48
Heating value of fuel, B. t. u. per pound dry fuel	13,207	13,207	12,773	14,092	13,900
Force of draft:					
Under stack damper, inch water	0.55	0.80	0.74	0.65	0.62
Above fire, do	.15	.18	.20	.13	.10
Furnace temperature, °F	2,499	2,458	2,393	2,468	2,775
Dry fuel used per square foot of grate surface per hour, pounds	20.81	22.76	22.22	20.02	23.97
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.70	3.98	3.90	3.93	4.80
Percentage of rated horsepower of boiler developed	103.7	111.7	109.5	110.3	134.7
Water apparently evaporated per pound of fuel as fired, pounds	7.05	7.00	7.02	8.23	8.44
Water evaporated from and at 212° F:					
Per pound of fuel as fired, pounds	8.47	8.42	8.43	9.59	9.83
Per pound of dry fuel, do	8.90	8.77	8.80	9.84	10.03
Per pound of combustible, do	10.31	10.23	10.53	10.58	10.93
Efficiency of boiler, including grate, per cent	65.08	64.13	66.53	67.43	69.68
Fuel as fired:					
Per indicated horsepower hour, pounds	3.34	3.36	3.35	2.95	2.88
Per electrical horsepower hour, do	4.12	4.15	4.14	3.64	3.55
Dry fuel:					
Per indicated horsepower hour, do	3.18	3.22	3.21	2.87	2.82
Per electrical horsepower hour, do	3.92	3.94	3.97	3.55	3.48

Remarks.—Tests 409 and 411 on English briquets broken in two, which burned with a long flame and gave a very hot fire, with little smoke. They cracked open to a depth of about 1½ inches, but coked and held together until entirely consumed. No clinker; fine brown ash.

PRODUCER-GAS TEST.

Tennessee No. 1 (run of mine).

Test 115.—Duration of test, 50 hours. Average electrical horsepower, 169. Average B. t. u. per cubic foot of gas, 154.5. Total coal fired, 12,300 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower developed at switchboard	1.46	1.42	1.24
Per brake horsepower developed at engine	1.24	1.20	1.05
Equivalent used by producer plant (pounds).			
Per electrical horsepower developed at switchboard	1.56	1.51	1.32
Per brake horsepower developed at engine	1.32	1.29	1.12

Analyses.

Coal.		*Gas by volume.*	
Moisture	2.72	Carbon dioxide (CO_2)	10.0
Volatile matter	31.81	Carbon monoxide (CO)	19.6
Fixed carbon	53.20	Hydrogen (H_2)	15.3
Ash	12.27	Methane (CH_4)	2.1
Sulphur	1.26	Nitrogen (N_2)	52.6
		Ethylene (C_2H_4)	.4

WASHING AND COKING TESTS.

Tennessee No. 1 (run of mine).

Washing test 171.—Size as used, crushed to 2 inches, jig used, Stewart. Raw coal, 21,600 pounds; washed coal, 18,600 pounds; refuse, 3,000 pounds.

Coking tests.

		Test 133 (raw).	Test 153 (w.).
Size as used		f. c.	f. c.
Duration of test	hours	49	43
Coal charged	pounds	12,000	11,900
Coke produced	do	7,720	7,270
	per cent	64.33	61.09
Breeze produced	pounds	347	273
	per cent	2.89	2.29
Total yield	do	67.22	63.38

Remarks.—Test 133: Light gray and silvery; strong, hard, heavy coke. Test 153: Light gray and silvery; good, strong, heavy coke; washing reduces ash and sulphur.

Analyses.

	Washing test 171.		Coking test 133.		Coking test 153.	
	Raw coal.[a]	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	4.81	5.28	3.71	0.37	4.86	0.93
Volatile matter	32.91	.....	32.81	.73	35.06	.77
Fixed carbon	51.13	.....	51.69	83.00	54.72	89.61
Ash	11.15	5.33	11.79	15.90	5.36	8.69
Sulphur	1.58	1.32	1.58	1.35	1.17	.93

[a] Sample taken from steaming test 344.

Cupola tests of coke made from Tennessee No. 1 coal (washed).

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Phosphorus.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
			Per ct.		*Per ct.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
						Coke	190	60	60	60	60	430
126	133	1.96	0.0238	7	97.22	Pig iron	570	420	420	420	420	2,250
						Scrap	190	140	140	140	140	750
						Coke	200	57	57	58	58	430
99	153	1.87	.0253	7	92.00	Pig iron	600	412	412	413	413	2,250
						Scrap	200	137	137	138	138	750
						Coke	200	58	58	57	57	430
128	153	1.87	.0253	7	99.9	Pig iron	600	413	413	412	412	2,250
						Scrap	200	138	138	137	137	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
126	9.58 a. m.	7	10	1,240	244	1,484	33	2,698	4.67	5.80	1,342	112
99	8.47 a. m.	7	7	1,443	563	2,006	34	3,540	6.19	11.60	646	106
128	3.11 p. m.	7	5	1,833	210	2,043	34	3,605	6.57	6.26	769	119

LADLE RECORD.

Ladle No.	Test 126. Pounds.	Test 126. Time (a. m.).	Test 99. Pounds.	Test 99. Time (a. m.).	Test 128. Pounds.	Test 128. Time (p. m.).
1	85	10.13	66	9.05	65	3.29
2	95	10.19	59	9.06	110	3.29½
3	98	10.19½	68	9.09	100	3.30
4	82	10.20	61	9.10	75	3.32
5	82	10.22	62	9.11	104	3.32½
6	81	10.22½	51	9.12	117	3.33
7	76	10.23	51	9.13	41	3.35½
8	68	10.28	61	9.14	91	3.36
9	95	10.28½	43	9.15	108	3.36½
10	74	10.29	58	9.16	72	3.38
11	108	10.34	52	9.16½	98	3.39
12	71	10.34½	42	9.17	108	3.40
13	87	10.35	88	9.18	87	3.40½
14	53	10.35½	50	9.19	123	3.41
15	85	10.41	45	9.20	92	3.46
16			73	9.21	93	3.46½
17			43	9.22	92	3.47
18			60	9.23	103	3.49
19			62	9.24	85	3.50
20			35	9.25	69	3.51
21			111	9.26		
22			63	9.27		
23			39	9.27½		
24			100	9.28		

Remarks.—Test 99: Iron very hot. Test 128: Blast off 1 minute.

BRIQUETTING TEST.

Tennessee No. 1 (run of mine).

Test 130.—Size as used: Over ¼ inch, 2.5 per cent; $\frac{1}{10}$ inch to ¼ inch, 7.7 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 17.8 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 24.1 per cent; through $\frac{1}{40}$ inch, 47.9 per cent. Kind of binder, water-gas pitch (lab. No. 3410, p. 40). Weight of fuel briquetted, 18,600 pounds. B. t. u. per pound of coal as received, 12,569; per pound of briquets as fired, 13,723; per pound of binder, 16,478. Weathering test: Days exposed, 201; condition, B. For analyses of briquets see page 225 (steaming tests 409 and 411).

English briquets with 5 and 6 per cent binder made at 179.6° F., average weight, 3.28 pounds, were good and firm; edges and surfaces harder with 6 per cent than with 5 per cent binder. Fractures of both were sharp and clear. In the drop test with 5 per cent binder the 1-inch screen held 84.4 per cent and passed 15.6 per cent.

Renfrow briquets made at 149° F., average weight 0.5 pound, with 6 and 6.5 per cent binder, showed dull fracture; edges broke easily, surfaces too soft. Those made with 7 per cent binder were satisfactory; fracture clear; edges sharp; briquets broke without crumbling.

Extraction analyses.

	Pitch.	Fuel.	Briquets test 130.
Laboratory No.	3410	.....	.....
Air-drying loss.....per cent.	.....	3.50	1.00
Extracted by CS_2:			
Air dried.....do....	.....	2.23	4.59
As received.....do....	79.98	2.15	4.54
Pitch in briquets as received.....do....	.....	.....	3.07

TENNESSEE NO. 2.

Bituminous coal from a mine located 2½ miles northeast of Gatliff, Campbell County, on the Louisville and Nashville Railroad, was designated Tennessee No. 2. The coal, as worked from the outcrop at this place, averages 3 feet 6 inches in thickness.

This sample, consisting of run-of-mine coal loaded under the supervision of John W. Groves, was used in making steaming tests 367, 368, and 369; producer-gas test 107; coking test 127, and cupola tests 100 and 140.

Two mine samples were taken for chemical analyses. Sample 2931 was taken 687 feet northeast of the opening, where the coal measured 3 feet 8 inches in thickness. Sample 2932 was taken 675 feet south of the opening, where the coal measured 3 feet 7 inches in thickness.

CHEMICAL ANALYSES.

Tennessee No. 2.

	Mine samples.		Car samples.[a]	Steaming tests.[b]		
				367.	368.	369.
Laboratory No	2931	2932	3129	.....	.....	.....
Air-drying loss	1.50	1.20	3.20	.....	.....	.....
Proximate:						
Moisture	3.61	3.19	5.09	4.68	5.09	5.17
Volatile matter	37.29	38.08	35.79	36.00	35.79	35.55
Fixed carbon	55.69	56.35	52.31	53.39	52.31	52.85
Ash	3.41	2.38	6.81	5.93	6.81	6.43
Sulphur	.83	.88	.98	.98	.98	.95
Ultimate:						
Hydrogen	.....	.....	5.39	5.13	5.08	5.10
Carbon	.....	.....	73.54	78.28	77.48	77.84
Nitrogen	.....	.....	1.75	1.87	1.84	1.86
Oxygen	.....	.....	11.53	7.47	7.39	7.42
Ash	.....	.....	.....	6 22	7.18	6.78
Sulphur	.....	.....	.....	1.03	1.03	1.00
Calorific value (as received):						
Determined, calories	7,850	.....	7,386	.....	.....	.....
Determined, B. t. u.	14,130	.....	13,295	.....	.....	.....
Calculated from ultimate analysis, calories	.....	.....	7,325	.....	.....	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	13,185	.....	.....	.....

[a] Sample from steaming test 368 treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample

STEAMING TESTS.

Tennessee No. 2 (run of mine).

	Test 367.[a]	Test 368.	Test 369.
Size as used:			
Over 1 inch ...per cent..	43.2	42.8	49.4
½ inch to 1 inch ...do....	23.9	18.4	22.4
¼ inch to ½ inch ...do....	13.0	12.2	11.8
Under ¼ inch ...do....	19.9	26.6	16.4
Duration of test ...hours..	9.97	9.98	9.97
Heating value of coal ...B. t. u. per pound dry coal..	14,153	14,008	14,069
Force of draft:			
Under stack damper ...inch water..	0.68	0.48	0.33
Above fire ...do....	.19	.11	.08
Furnace temperature ...°F..	2,788	2,488	2,250
Dry coal used per square foot of grate surface per hour ...pounds..	26.41	19.16	15.24
Equivalent water evaporated per square foot of water-heating surface per hour ...pounds..	4.63	3.65	2.93
Percentage of rated horsepower of boiler developed	129.9	102.3	82.3
Water apparently evaporated per pound of coal as fired ...pounds..	7.10	7.63	7.75
Water evaporated from and at 212° F.:			
Per pound of coal as fired ...do....	8.38	9.06	9.14
Per pound of dry coal ...do....	8.79	9.54	9.64
Per pound of combustible ...do....	9.46	10.52	10.57
Efficiency of boiler, including grate ...per cent..	59.98	65.77	66.17
Coal as fired:			
Per indicated horsepower hour ...pounds..	3.37	3.12	3.09
Per electrical horsepower hour ...do....	4.17	3.85	3.82
Dry coal:			
Per indicated horsepower hour ...do....	3.22	2.96	2.93
Per electrical horsepower hour ...do....	3.97	3.66	3.62

[a] Test run for maximum capacity.

PRODUCER-GAS TEST.

Tennessee No. 2 (run of mine).

Test 107.—Duration of test, 50 hours. Average electrical horsepower, 201.3. Average B. t. u. per cubic foot of gas, 167.9. Total coal fired, 11,250 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.18	1.14	1.08
Developed at switchboard	1.12	1.08	1.03
Per brake horsepower:			
Commercially available	1.00	.97	.92
Developed at engine	.95	.92	.87
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.30	1.26	1.20
Developed at switchboard	1.24	1.20	1.14
Per brake horsepower:			
Commercially available	1.11	1.07	1.02
Developed at engine	1.05	1.02	.96

Analyses.

Coal.		*Gas by volume.*	
Moisture	3.40	Carbon dioxide (CO_2)	10.9
Volatile matter	37.58	Carbon monoxide (CO)	18.8
Fixed carbon	54.27	Hydrogen (H_2)	18.6
Ash	4.75	Methane (CH_4)	2.2
Sulphur	.83	Nitrogen (N_2)	49.0
		Ethylene (C_2H_4)	.5

COKING TEST.

Tennessee No. 2 (run of mine).

Test 127.—Size as used: Raw, finely crushed. Duration of test, 54 hours. Coal charged, 12,000 pounds. Coke produced, 7,213 pounds; 60.11 per cent. Breeze produced, 343 pounds; 2.86 per cent. Total yield, 62.97 per cent. Fine-fingered coke; very brittle and breaks very easily on handling; light gray, with large carbon deposit.

Analyses.

	Coal.	Coke.
Moisture	3.56	1.13
Volatile matter	36.53	.63
Fixed carbon	55.32	91.00
Ash	4.59	7.23
Sulphur	.95	.78

Cupola tests of coke made from Tennessee No. 2 coal.

CHARGE.

Cupola test No.	Coke.[a] Test No.	Coke.[a] Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
100	127	1.81	1 to 7	99.9	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750
140	127	1.81	1 to 7	94.44	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750

[a] Phosphorus in coke, 0.0094 per cent.

Cupola tests of coke made from Tennessee No. 2 coal—Continued.

RECORD OF MELT.

Cupola test No.	Blast pressure.		Iron running in—	Weight of iron.			Melting.				Recovered.	
	On at—	Maximum.		Poured.	Additional melted.	Total.	Time.	Rate per hour.	Ratio iron to coke.	Loss.	Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
100	1.20 p. m....	7	7	1,551	556	2,107	33	3,830	5.79	6.46	699	66
140	2.47 p. m....	7	6	2,080	270	2,350	34	4,147	5.97	5.77	477	36

LADLE RECORD.

Ladle No.	Test 100.		Test 140.		Ladle No.	Test 100.		Test 140.	
	Pounds.	Time (p. m.).	Pounds.	Time (p. m.).		Pounds.	Time (p. m.).	Pounds.	Time (p. m.).
1	52	1.35	28	2.59	14	51	1.49	107	3.15½
2	34	1.35½	110	3.01	15	61	1.50	61	3.16
3	64	1.40	44	3.01½	16	53	1.50½	80	3.18
4	70	1.40½	90	3.04	17	50	1.51	111	3.18½
5	52	1.41	78	3.07	18	81	1.52	57	3.19
6	94	1.42	106	3.07½	19	58	1.52½	79	3.21
7	79	1.42½	102	3.08	20	46	1.53	108	3.21½
8	73	1.43	80	3.10	21	82	1.55	71	3.22
9	80	1.45½	101	3.10½	22	49	1.55½	77	3.23
10	67	1.46	82	3.11	23	49	1.56	101	3.23½
11	60	1.46½	83	3.13	24	60	1.59	57	3.24
12	68	1.48	78	3.13½	25	58	2.00	63	3.26½
13	60	1.48½	83	3.15	26	.....	.....	43	3.27

Remarks.—Test 100: Iron very hot and fluid. Test 140: Iron medium.

TENNESSEE NO. 3.

Bituminous coal from Gatliffe, Campbell County, on the Louisville and Nashville Railroad, was designated Tennessee No. 3. The coal, as worked at the outcrop at this place, averages 4 feet 6 inches in thickness.

This sample, consisting of run-of-mine coal, shipped under the supervision of John W. Groves, was used in making steaming tests 349 and 350; producer-gas test 106; coking test 128, and cupola tests 104 and 139.

Two mine samples were taken for chemical analysis. Sample 2929 was taken 500 feet south of the drift mouth, where the coal measured 5 feet 2 inches in thickness. Sample 2930 was taken 1,050 feet southwest of the drift mouth, where the coal measured 4 feet 5½ inches in thickness.

CHEMICAL ANALYSES.

Tennessee No. 3.

	Mine samples.		Car samples.[a]	Steaming tests.[b]	
				349.	350.
Laboratory No.	2929	2930	3040	.....	.....
Air-drying loss	1.80	1.90	3.20	.....	.....
Proximate:					
Moisture	4.25	4.42	5.38	5.38	6.47
Volatile matter	35.31	35.35	34.54	34.54	33.92
Fixed carbon	56.31	57.53	53.03	53.03	52.13
Ash	4.13	2.70	7.05	7.05	7.48
Sulphur	.93	.80	.99	.99	1.13
Ultimate:					
Hydrogen	.....	.....	5.50	5.18	5.14
Carbon	.....	.....	72.41	76.52	75.93
Nitrogen	.....	.....	1.72	1.82	1.81
Oxygen	.....	.....	12.33	7.98	7.91
Ash	.....	.....	.....	7.45	8.00
Sulphur	.....	.....	.....	1.05	1.21
Calorific value (as received):					
Determined, calories	7,592	.....	7,249	.....	.....
Determined, B. t. u.	13,666	.....	13,048	.....	.....
Calculated from ultimate analysis, calories	.....	.....	7,238	.....	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	13,028	.....	.....

[a] Sample from steaming test 349 treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Tennessee No. 3 (run of mine).

	Test 349.	Test 350.
Size as used:		
Over 3 inches, per cent	67.8	59.1
Over 1 inch, do	19.3	20.0
½ inch to 1 inch, do	5.4	9.1
¼ inch to ½ inch, do	2.7	4.6
Under ¼ inch, do	4.8	7.2
Duration of test, hours	8.97	10.0
Heating value of coal, B. t. u. per pound dry coal	13,788	13,689
Force of draft:		
Under stack damper, inch water	0.57	0.80
Above fire, do	.14	.14
Furnace temperature, °F.	2,664	2,562
Dry coal used per square foot of grate surface per hour, pounds	21.70	21.63
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.75	4.07
Percentage of rated horsepower of boiler developed	105.0	114.0
Water apparently evaporated per pound of coal as fired, pounds	6.81	7.31
Water evaporated from and at 212° F.:		
Per pound of coal as fired, do	8.18	8.82
Per pound of dry coal, do	8.65	9.43
Per pound of combustible, do	9.49	10.35
Efficiency of boiler, including grate, per cent	60.58	66.52
Coal as fired:		
Per indicated horsepower hour, pounds	3.46	3.21
Per electrical horsepower hour, do	4.27	3.96
Dry coal:		
Per indicated horsepower hour, do	3.27	3.00
Per electrical horsepower hour, do	4.04	3.70

PRODUCER-GAS TEST.

Tennessee No. 3 (run of mine).

Test 106.—Duration of test, 50 hours. Average electrical horsepower, 201. Average B. t. u. per cubic foot of gas, 159.7. Total coal fired, 12,950 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.38	1.31	1.22
Developed at switchboard	1.29	1.23	1.14
Per brake horsepower:			
Commercially available	1.17	1.11	1.04
Developed at engine	1.10	1.04	.97
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.50	1.42	1.32
Developed at switchboard	1.40	1.33	1.24
Per brake horsepower:			
Commercially available	1.27	1.21	1.12
Developed at engine	1.19	1.13	1.05

Analyses.

Coal.		*Gas by volume.*	
Moisture	4.88	Carbon dioxide (CO_2)	9.8
Volatile matter	34.84	Carbon monoxide (CO)	20.2
Fixed carbon	53.57	Hydrogen (H_2)	16.5
Ash	6.71	Methane (CH_4)	2.4
Sulphur	1.16	Nitrogen (N_2)	50.7
		Ethylene (C_2H_4)	.4

COKING TEST.

Tennessee No. 3 (run of mine).

Test 128.—Size as used: Raw, finely crushed. Duration of test, 42 hours. Coal charged, 11,280 pounds. Coke produced, 7,136 pounds; 63.26 per cent. Breeze produced, 394 pounds; 3.49 per cent. Total yield, 66.75 per cent. Fingered coke; light gray, with large deposit of carbon.

Analyses.

	Coal.	Coke.
Moisture	4.32	0.67
Volatile matter	33.90	.81
Fixed carbon	55.56	87.44
Ash	6.22	11.08
Sulphur	1.05	.88

Cupola tests of coke made from Tennessee No. 3 coal.

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
104	128	1.87	7	95.83	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750
139	128	1.87	7	97.81	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750

[a] Phosphorus in coke, 0.0125 per cent.

Cupala tests of coke made from Tennessee No. 3 coal—Continued.

RECORD OF MELT.

Cupola test No.	Blast pressure.		Iron running in—	Weight of iron.			Melting.				Recovered.	
	On at—	Maximum.		Poured.	Additional melted.	Total.	Time.	Rate per hour.	Ratio iron to coke.	Loss.	Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
104	9.08 a. m...	7½	8	1,477	429	1,906	35	3,267	5.51	7.93	856	84
139	10.43 a. m...	6½	9	1,913	239	2,152	32	4,035	5.55	6.60	650	50

LADLE RECORD.

Ladle No.	Test 104.		Test 139.		Ladle No.	Test 104.		Test 139.	
	Pounds.	Time (a. m.).	Pounds.	Time (a. m.).		Pounds.	Time (a. m.).	Pounds.	Time (a. m.).
1	50	9.21	93	10.56	15	36	9.40	76	11.17
2	64	9.21½	93	10.59	16	101	9.40½	115	11.17½
3	62	9.22	100	10.59½	17	39	9.41	110	11.18
4	77	9.24	81	11.02	18	42	9.42	65	11.23
5	82	9.25	62	11.02½	19	77	9.42½	112	11.23½
6	20	9.25½	89	11.06	20	41	9.43	115	11.24
7	57	9.31	81	11.06½	21	38	9.44	.....	.....
8	68	9.31½	101	11.07	22	74	9.44½	.....	.....
9	64	9.32	87	11.09	23	24	9.45	.....	.....
10	61	9.36	117	11.09½	24	29	9.48	.....	.....
11	50	9.36½	108	11.10	25	63	9.48½	.....	.....
12	42	9.37	85	11.13	26	27	9.49	.....	.....
13	84	9.38	122	11.13½	27	62	9.51	.....	.....
14	43	9.38½	101	11.14					

Remarks.—Test 104: Iron hot and fluid. Test 139: Iron hot.

TENNESSEE NO. 4.

Bituminous coal from a mine located 3 miles north of Oliver Springs, Roane County, on the Louisville and Nashville Railroad, was designated Tennessee No. 4. The coal, as worked at the outcrop at this place, averages 4 feet 8 inches in thickness.

This sample, consisting of run-of-mine coal, loaded under the supervision of John W. Groves, was used in making steaming tests 355, 356, and (on briquets) 405; producer-gas test 111; coking tests 125 and 129; cupola tests 102, 105, and 138; and briquetting tests 120 and (mixed with miscellaneous No. 5, p. 292) 150 and 151.

Two mine samples were taken for chemical analysis. Sample 2956 was taken 1,300 feet northeast of the drift mouth, where the coal measured 4 feet 5½ inches in thickness. Sample 2957 was taken 2,000 feet south of the drift mouth, where the coal measured 5 feet 2 inches in thickness.

CHEMICAL ANALYSES.

Tennessee No. 4.

	Mine samples.		Car sample.[a]	Steaming tests.[b]			Briquetting tests.[c]	
				355.	356.	405.	150.	151.
Laboratory No.	2956	2957	3058				3380	3367
Air-drying loss	1.90	1.70	4.70					
Proximate:								
Moisture	3.25	3.12	6.39	6.39	5.72	2.88	2.55	2.71
Volatile matter	35.63	35.15	32.32	32.32	31.78	35.78	31.91	29.56
Fixed carbon	54.51	55.52	51.76	51.76	51.91	53.84	57.42	58.41
Ash	6.61	6.21	9.53	9.53	10.59	7.50	8.12	9.32
Sulphur	.85	.86	.98	.98	.92	.91	.92	.93
Ultimate:								
Hydrogen			5.41	5.02	4.96	4.73	4.34	4.15
Carbon			70.16	74.95	74.13	77.93	78.53	78.40
Nitrogen			1.56	1.67	1.64	1.79	1.71	1.67
Oxygen			12.36	7.13	7.06	6.89	6.15	5.60
Ash				10.18	11.23	7.72	8.33	9.58
Sulphur				1.05	.98	.94	.94	.96
Calorific value (as received):								
Determined, calories	7,508		6,988					
Determined, B. t. u.	13,514		12,578					
Calculated from ultimate analysis, calories			7,023					
Calculated from ultimate analysis, B. t. u.			12,641					

[a] Sample from steaming test 355 treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[c] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Tennessee No. 4 (run of mine).

	Test 355.	Test 356.[a]	Test 405.
Size as used:			
Over 1 inch, per cent	20.1	32.0	See p. 238
½ inch to 1 inch, do	25.2	19.6	
¼ inch to ½ inch, do	21.6	19.0	
Under ¼ inch, do	33.1	29.4	
Duration of test, hours	10	9.97	8.25
Heating value of fuel, B. t. u. per pound dry fuel	13,441	13,288	13,936
Force of draft:			
Under stack damper, inch water	0.74	0.76	0.64
Above fire, do	.16	.22	.18
Furnace temperature, °F.	2,584	2,719	2,294
Dry fuel used per square foot of grate surface per hour, pounds	21.49	24.34	19.16
Equivalent water evaporated per square foot of water-heating surface, per hour, pounds	3.95	4.48	3.76
Percentage of rated horsepower of boiler developed	110.8	125.6	105.3
Water apparently evaporated per pound of fuel as fired, pounds	7.36	7.48	8.22
Water evaporated from and at 212° F.:			
Per pound of fuel as fired, do	8.62	8.69	9.54
Per pound of dry fuel, do	9.21	9.22	9.82
Per pound of combustible, do	10.39	10.53	10.79
Efficiency of boiler, including grate, per cent	66.17	67.01	68.05
Fuel as fired:			
Per indicated horsepower hour, pounds	3.28	3.25	2.96
Per electrical horsepower hour, do	4.05	4.02	3.66
Dry fuel:			
Per indicated horsepower hour, do	3.07	3.07	2.88
Per electrical horsepower hour, do	3.79	3.79	3.55

[a] Test made for maximum capacity.

Remarks.—Test 405 on briquets, which burned with a long flame and cracked open to a depth of three-fourths inch; coked and held together until entirely consumed; made very little smoke. Fine gray ash of medium weight, with very little green coal, loss of coal falling through grate and over bridge wall being very small.

PRODUCER-GAS TEST.

Tennessee No. 4 (run of mine).

Test 111.—Duration of test, 50 hours. Average electrical horsepower, 182. Average B. t. u. per cubic foot of gas, 161.7. Total coal fired, 12,150 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.42	1.37	1.27
Developed at switchboard	1.34	1.29	1.19
Per brake horsepower:			
Commercially available	1.21	1.17	1.08
Developed at engine	1.13	1.10	1.01
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.54	1.49	1.38
Developed at switchboard	1.45	1.40	1.29
Per brake horsepower:			
Commercially available	1.31	1.27	1.17
Developed at engine	1.23	1.19	1.10

Analyses.

Coal.		*Gas by volume.*	
Moisture	3.29	Carbon dioxide (CO_2)	10.4
Volatile matter	34.49	Carbon monoxide (CO)	19.0
Fixed carbon	54.82	Hydrogen (H_2)	16.7
Ash	7.40	Methane (CH_4)	2.4
Sulphur	.88	Nitrogen (N_2)	51.0
		Ethylene (C_2H_4)	.5

COKING TESTS.

Tennessee No. 4 (run of mine).

		Test 125.	Test 129.
Size as used		f. c.	f. c.
Duration of test	hours.	60	53
Coal charged	pounds.	12,000	11,270
Coke produced	do.	7,471	7,500
	per cent.	62.26	66.55
Breeze produced	pounds.	313	266
	per cent.	2.61	2.36
Total yield	do.	64.87	68.91

Remarks.—Test 125: Light gray and silvery color; fingered coke ¾-inch black butts; ash somewhat high; better coke probably from washed coal. Test 129: Light gray and silvery; fingered coke; black butts removed; heavier and better than coke of test 125; resultant coke probably improved by washing.

Analyses.

	Coal.	Coke.	
		Test 125.	Test 129.
Moisture	3.82	0.54	1.43
Volatile matter	33.17	1.56	0.28
Fixed carbon	53.17	84.27	86.73
Ash	9.84	13.63	11.56
Sulphur	.89	.72	.69

Cupola tests of coke made from Tennessee No. 4 coal.

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Phosphorus.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
			Per ct.		*Per ct.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
102	125	1.93	0.0215	7	98.61	Coke.....	190	60	60	60	60	430
						Pig iron...	570	420	420	420	420	2,250
						Scrap.....	190	140	140	140	140	750
105	129	1.91	.0233	7	99.0	Coke.....	190	60	60	60	60	430
						Pig iron...	570	420	420	420	420	2,250
						Scrap.....	190	140	140	140	140	750
138	129	1.91	.0233	7	94.44	Coke.....	190	60	60	60	60	430
						Pig iron...	570	420	420	420	420	2,250
						Scrap.....	190	140	140	140	140	750

a Sulphur in ash, test 102, 0.03 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Maximum.	Iron running in—	Weight of iron. Poured.	Additional melted.	Total.	Melting. Time.	Rate per hour.	Ratio iron to coke.	Loss.	Recovered. Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
102	3.15 p. m....	7	8	1,731	219	1,950	32	3,656	5.57	6.60	852	79
105	2.25 p. m....	7½	7	1,915	131	2,046	31	3,960	5.81	6.70	753	78
138	3.51 p. m....	7	9	1,875	252	2,127	40	3,191	6.09	6.16	688	81

LADLE RECORD.

Ladle No.	Test 102. Pounds.	Time (p. m.).	Test 105. Pounds.	Time (p. m.).	Test 138. Pounds.	Time (p. m.).
1	104	3.32	94	2.38	87	4.03
2	62	3.32½	98	2.38½	73	4.06
3	95	3.35	48	2.39	84	4.06½
4	79	3.35½	89	2.42	46	4.07
5	86	3.38	111	2.43	89	4.09
6	22	3.38½	113	2.43½	79	4.11
7	79	3.40	87	2.46	106	4.11½
8	91	3.41½	104	2.46½	60	4.12
9	76	3.42	97	2.47	98	4.14
10	107	3.45	95	2.48	31	4.14½
11	107	3.45½	98	2.48½	78	4.18
12	81	3.46	89	2.50	116	4.18½
13	103	3.48	88	2.51	93	4.19
14	110	3.48½	91	2.51½	71	4.23
15	55	3.49	105	2.53	92	4.23½
16	103	3.50	34	2.54	122	4.24
17	84	3.51	91	2.56	92	4.28
18	74	3.54	100	2.57½	102	4.28½
19	108	3.54½	86	2.58	77	4.29
20	105	3.55	70	3.00	103	4.32
21			127	3.03	26	4.32½
22					74	4.35
23					27	4.35½
24					49	4.40

Remarks.—Tests 102 and 138: Iron hot. Test 105: Iron very hot and fluid.

BRIQUETTING TESTS.

Tennessee No. 4 (run of mine).

Test 120.—English briquets made at 179.6° F., average weight 3.3 pounds, with 5 per cent binder, were easily broken, showing cracks with soft edges; those made with 5.5 per cent binder showed improvement, but the edges were not sharp, and the

briquets were easily broken; those with 6 per cent binder were satisfactory, showing firm edges, hard surfaces, and clean, sharp fracture; those with 6.5 per cent binder showed improvement on surfaces and edges. In the drop test with briquets containing 5 per cent binder the 1-inch screen held 83.3 per cent and passed 15.7 per cent; with 5.5 per cent binder 85.4 per cent was held and 14.6 per cent passed. Renfrow briquets made at 149° F., average weight 0.4 pound, with 6, 6.5, and 7 per cent binder, had smooth, firm surfaces and edges slightly soft, though generally satisfactory; 7.5 per cent binder made the best briquets of the lot; all surfaces and fractures were entirely satisfactory. For analyses of briquets see page 235 (steaming test 405).

Test 150.—Tennessee No. 4, 80 per cent; miscellaneous No. 5 (coke breeze, p. 292) 20 per cent. Briquets with 8 per cent binder were satisfactory, with no difference in appearance from those made from Tennessee No. 4 alone. They were tough when warm, easily handled and stored, and had rough but hard surfaces. The briquets were difficult to break; the fracture was uneven, although the edges were firm. The structure was porous.

Test 151.—Tennessee No. 4, 75 per cent; miscellaneous No. 5, 25 per cent. With the increased percentage of coke breeze (see test 150) the briquets were easily broken when warm, although sufficiently tough after cooling.

	Test 120.	Test 150.	Test 151.
Size as used:			
Over ¼ inch....per cent..	3.2	3.2	3.2
⅛ inch to ¼ inch....do....	11.4	10.9	10.9
1/20 inch to ⅛ inch....do....	19.9	18.6	18.6
1/40 inch to 1/20 inch....do....	25.0	25.8	25.8
Under 1/40 inch....do....	40.0	41.5	41.5
Details of manufacture:			
Machine used	(a)	Renf.	Renf.
Temperature of briquets....°F..	(a)	149	149
Binder—			
Kind	w. g. p.	w. g. p.	w. g. p.
Laboratory No. (see p. 40)	3410	3410	3410
Amount....per cent..	(a)	8	8
Weight of—			
Fuel briquetted	44,000	40,000	40,000
Briquets, average	(a)	.532	.513
Heat value per pound—			
Fuel as received {Tennessee No. 4....B. t. u..	12,578	12,578	12,576
Fuel as received {Miscellaneous No. 5....do....	.....	11,036	11,036
Fuel as fired....do....	13,578	13,536	13,154
Binder....do....	16,478	16,478	16,478
Weathering test:			
Time exposed....days..	214	214	214
Condition	B.	B.	B.

[a] See notes preceding table.

Extraction analyses.

	Pitch.	Fuels.		Briquets.		
		Tenn. No. 4.	Misc. No. 5.	Test 120.	Test 150.	Test 151.
Laboratory No.	3410	3058	3366	.....	3380	3367
Air-drying loss....per cent..	.....	4.70	8.70	1.10	0.60	0.60
Extracted by CS_2:						
Air-dried....do....	.....	1.50	.65	5.82	6.27	6.56
As received....do....	79.98	1.38	.59	5.75	6.23	6.52
Pitch in briquets as received....do....	.....	.....	.....	5.56	7.29	7.51

TENNESSEE NO. 5.

Bituminous coal from Petros, Morgan County, on the Southern Railway, was designated Tennessee No. 5. The coal, as worked from the outcrop at this place, averages 2 feet 10 inches in thickness.

This sample, consisting of run-of-mine coal inspected and loaded under the supervision of John W. Groves, was used in making steaming tests 352, 357, and 358; producer-gas test 125; washing test 172; coking test 154 (washed coal); and cupola tests 106 and 129.

Two mine samples were taken for chemical analysis. Sample 2958 was taken 2,500 feet southeast of the drift mouth, where the coal measured 2 feet 8½ inches in thickness. Sample 2959 was taken 3,800 feet east of the drift mouth, where the coal measured 3 feet ½ inch in thickness.

CHEMICAL ANALYSES.

Tennessee No. 5.

	Mine samples.		Car samples.[a]	Steaming tests.[b]		
				352.	357.	358.
Laboratory No	2958	2959	3050	.....	.....	.....
Air-drying loss	1.30	0.90	4.30	.....	.....	.....
Proximate:						
Moisture	2.25	2.20	5.59	5.59	5.82	6.73
Volatile matter	35.37	36.76	33.62	33.62	33.59	32.84
Fixed carbon	55.47	52.84	51.03	51.03	51.73	51.12
Ash	6.91	8.20	9.76	9.76	8.86	9.31
Sulphur	2.96	3.84	3.23	3.33	.....	2.95
Ultimate:						
Hydrogen	.....	.....	5.24	4.89	4.89	4.93
Carbon	.....	.....	70.08	74.23	74.23	74.76
Nitrogen	.....	.....	1.62	1.72	1.72	1.73
Oxygen	.....	.....	10.07	5.40	5.40	5.44
Ash	.....	.....	.....	10.34	10.34	9.98
Sulphur	.....	.....	.....	3.42	3.42	3.16
Calorific value (as received):						
Determined, calories	7,695	.....	7,135	.....	.....	.....
Determined, B. t. u.	13,851	.....	12,841	.....	.....	.....
Calculated from ultimate analysis, calories	.....	.....	7,107	.....	.....	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	12,793	.....	.....	.....

[a] Sample from steaming test 352 treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Tennessee No. 5 (run of mine).

	Test 352.	Test 357.	Test 358.
Size as used:			
Over 1 inch, per cent	29.1	12.9	19.9
½ inch to 1 inch, do	17.3	25.8	28.2
¼ inch to ½ inch, do	20.9	21.9	20.6
Under ¼ inch, do	32.7	39.4	31.3
Average diameter, inch	.86	.58	.69
Duration of test, hours	9.98	10.00	10.00
Heating value of coal, B. t. u. per pound dry coal	13,604	13,792	13,685
Force of draft:			
Under stack damper, inch water	0.62	0.74	0.75
Above fire, do	.13	.21	.20
Furnace temperature, °F.	2,456	2,575	2,520
Dry coal used per square foot of grate surface per hour, pounds	18.89	22.49	22.12
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.40	3.97	4.12
Percentage of rated horsepower of boiler developed	95.4	111.2	115.5
Water apparently evaporated per pound of coal as fired, pounds	7.08	7.14	7.49
Water evaporated from and at 212° F.:			
Per pound of coal as fired, do	8.52	8.33	8.69
Per pound of dry coal, do	9.02	8.84	9.32
Per pound of combustible, do	10.31	9.89	10.52
Efficiency of boiler, including grate, per cent	64.03	61.80	65.77
Coal as fired:			
Per indicated horsepower hour, pounds	3.32	3.39	3.25
Per electrical horsepower hour, do	4.10	4.19	4.02
Dry coal:			
Per indicated horsepower hour, do	3.13	3.20	3.03
Per electrical horsepower hour, do	3.87	3.95	3.75

PRODUCER-GAS TEST.

Tennessee No. 5 (run of mine).

Test 125.—Duration of test, 50 hours. Average electrical horsepower, 186.7. Average B. t. u. per cubic foot of gas, 142.1. Total coal fired, 12,900 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.48	1.44	1.31
Developed at switchboard	1.38	1.35	1.23
Per brake horsepower:			
Commercially available	1.26	1.23	1.11
Developed at engine	1.18	1.15	1.04
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.61	1.57	1.43
Developed at switchboard	1.51	1.47	1.34
Per brake horsepower:			
Commercially available	1.37	1.34	1.24
Developed at engine	1.28	1.25	1.14

Analyses.

Coal.		*Gas by volume.*	
Moisture	2.54	Carbon dioxide (CO_2)	11.3
Volatile matter	34.64	Carbon monoxide (CO)	17.0
Fixed carbon	53.96	Hydrogen (H_2)	15.3
Ash	8.86	Methane (CH_4)	1.7
Sulphur	3.39	Nitrogen (N_2)	54.2
		Ethylene (C_2H_4)	.5

WASHING AND COKING TESTS.

Washing test 172.—Size as used: Crushed to 2 inches. Jig used, Stewart. Raw coal, 18,450 pounds; washed, 16,000 pounds; refuse, 2,450 pounds.

Coking test 154.—Size as used: Washed, finely crushed. Duration of test, 49 hours. Coal charged, 11,570 pounds. Coke produced, 6,807 pounds, 58.83 per cent. Breeze produced, 354 pounds, 2.20 per cent. Total yield, 61.03 per cent. Light gray and silvery. Good, strong, heavy coke. High sulphur not removed by washing.

Analyses.

	Washing test 172.		Coking test 154.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	5.59	5.29	5.53	0.56
Volatile matter	33.62	.....	35.06	.42
Fixed carbon	51.03	.....	53.28	90.46
Ash	9.76	5.64	6.13	8.56
Sulphur	3.23	2.46	2.44	2.08

Cupola tests of coke made from Tennessee No. 5 coal (washed).

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
106	154	1.91	7	98.51	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750
129	154	1.91	7	93.05	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
106	9.13	7	7	2,328	144	2,472	31	4,784	6.92	8.30	279	73
129	9.44	7	6	1,825	418	2,243	34	3,958	6.30	6.13	573	74

LADLE RECORD.

Ladle No.	Test 106. Pounds.	Test 106. Time (a. m.).	Test 129. Pounds.	Test 129. Time (a. m).	Ladle No.	Test 106. Pounds.	Test 106. Time (a. m.).	Test 129. Pounds.	Test 129. Time (a. m.).
1	103	9.25	80	9.58	13	111	9.38½	80	10.14
2	107	9.25½	65	9.59	14	103	9.39	104	10.14½
3	80	9.26	91	10.05	15	88	9.40	78	10.15½
4	86	9.29	64	10.06	16	111	9.40½	115	10.16
5	109	9.30	87	10.09	17	111	9.41	108	10.16½
6	116	9.31	88	10.09½	18	98	9.42	84	10.17
7	89	9.32	64	10.10	19	101	9.42½	83	10.17½
8	108	9.32½	76	10.11½	20	97	9.43	32	10.18
9	89	9.35	84	10.12	21	74	9.46½	90	10.23
10	81	9.35½	102	10.12½	22	105	9.46	75	10.24
11	100	9.36	95	10.13	23	124	9.47	.....	.....
12	87	9.38	80	10.13½	24	50	9.51	.....	.....

Remarks.—Test 106: Iron very hot and fluid.

TENNESSEE NO. 6.

Bituminous coal from a mine located 3 miles northwest of Waldensia, Cumberland County, on the Southern Railway, was designated Tennessee No. 6. The coal, as worked from the outcrop at this place, averages 4 feet in thickness.

The sample, consisting of run-of-mine coal inspected by John W. Groves, was used in making steaming tests 379, 380, and 381; producer-gas test 110; coking test 122; and cupola tests 112 and 141.

Two mine samples were taken for chemical analysis. Sample 2977 was taken 200 feet west of the drift mouth, where the coal measured 3 feet 6 inches in thickness. Sample 2978 was taken 350 feet northeast of the drift mouth, where the coal measured 4 feet 6 inches in thickness.

CHEMICAL ANALYSES.

Tennessee No. 6.

	Mine samples.		Car sample.	Steaming tests.[a]		
				379.	380.	381.
Laboratory No.	2977	2978	3102	.....	.....	.....
Air-drying loss	2.70	1.90	2.90	.....	.....	.....
Proximate:						
Moisture	3.80	3.00	3.89	2.74	3.18	3.16
Volatile matter	30.72	30.88	27.61	26.95	27.21	26.77
Fixed carbon	60.98	59.96	54.07	51.77	53.93	52.27
Ash	4.50	6.16	14.43	18.54	15.68	17.80
Sulphur	.78	1.08	.78	.74	.77	.75
Ultimate:						
Hydrogen	.....	.....	4.84	4.37	4.52	4.41
Carbon	.....	.....	70.04	69.42	71.88	69.98
Nitrogen	.....	.....	.98	.98	1.00	.98
Oxygen	.....	.....	8.93	5.41	5.61	5.47
Ash	.....	.....	.....	19.06	16.19	18.38
Sulphur	.....	.....	.....	.76	.80	.78
Calorific value (as received):						
Determined, calories	7,879	.....	6,952	.....	.....	.....
Determined, B. t. u.	14,182	.....	12,514	.....	.....	.....
Calculated from ultimate analysis, calories	.....	.....	6,959	.....	.....	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	12,526	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Tennessee No. 6 (run of mine).

	Test 379.	Test 380.	Test 381.
Size as used:			
Over 1 inch, per cent	27.7	.....	21.7
½ inch to 1 inch, do	27.8	.....	17.4
¼ inch to ½ inch, do	19.8	.....	19.6
Under ¼ inch, do	24.7	.....	41.3
Duration of test, hours	9.88	10.03	10.02
Heating value of coal, B. t. u. per pound dry coal	12,406	12,839	12,505
Force of draft:			
Under stack damper, inch water	0.59	0.67	0.70
Above fire, do	.14	.19	.19
Dry coal used per square foot of grate surface per hour, pounds	18.42	18.57	18.35
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.25	[a] 2.98	2.88
Percentage of rated horsepower of boiler developed	9.12	[a] 8.35	80.7
Water apparently evaporated per pound of coal as fired, pounds	7.30	[a] 6.59	6.42
Water evaporated from and at 212° F.:			
Per pound of coal as fired, do	8.61	[a] 7.78	7.61
Per pound of dry coal, do	8.85	[a] 8.04	7.86
Per pound of combustible, do	11.29	[a] 9.87	10.04
Efficiency of boiler, including grate, per cent	68.87	[a] 60.47	60.70
Coal as fired:			
Per indicated horsepower hour, pounds	3.28	[a] 3.63	3.72
Per electrical horsepower hour, do	4.05	[a] 4.49	4.59
Dry coal:			
Per indicated horsepower hour, do	3.20	[a] 3.52	3.60
Per electrical horsepower hour, do	3.94	[a] 4.34	4.44

[a] Questionable.

PRODUCER-GAS TEST.

Tennessee No. 6 (run of mine).

Test 110.—Duration of test, 30 hours. Average electrical horsepower, 156. Average B. t. u. per cubic foot of gas, 133.3. Total coal fired, 7,950 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.84	1.78	1.40
Developed at switchboard	1.70	1.64	1.28
Per brake horsepower:			
Commercially available	1.56	1.51	1.19
Developed at engine	1.45	1.39	1.10
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.02	1.95	1.53
Developed at switchboard	1.87	1.80	1.42
Per brake horsepower:			
Commercially available	1.72	1.66	1.30
Developed at engine	1.59	1.53	1.20

Analyses.

Coal.		*Gas by volume.*	
Moisture	3.55	Carbon dioxide (CO_2)	12.3
Volatile matter	26.00	Carbon monoxide (CO)	15.0
Fixed carbon	49.88	Hydrogen (H_2)	14.0
Ash	20.57	Methane (CH_4)	.19
Sulphur	.76	Nitrogen (N_2)	56.4
		Ethylene (C_2H_4)	.4

COKING TEST.

Tennessee No. 6 (run of mine).

Test 122.—Size as used: Raw, finely crushed. Duration of test, 43 hours. Coal charged, 12,000 pounds. Coke produced, 7,712 pounds; 64.27 per cent. Breeze produced, 314 pounds; 2.62 per cent. Total yield, 66.89 per cent. Light gray and silvery. Good, heavy, strong coke. Could be improved by washing to reduce ash.

Analyses.

	Coal.	Coke.
Moisture	2.05	0.22
Volatile matter	27.36	.91
Fixed carbon	55.12	79.01
Ash	15.47	19.86
Sulphur	.90	.69

Cupola tests of coke made from Tennessee No. 6 coal.

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
112	122	1.95	7	.....	Coke	230	50	50	50	50	430
					Pig iron	690	390	390	390	390	2,250
					Scrap	230	130	130	130	130	750
141	122	1.95	7	99.9	Coke	220	53	53	52	52	430
					Pig iron	660	398	398	397	397	2,250
					Scrap	220	133	133	132	132	750

[a] Sulphur in ash 0.03 per cent. Phosphorus in coke, 0.0834 per cent.

Cupola tests of coke made from Tennessee No. 6 coal—Continued.

RECORD OF MELT.

Cupola test No.	Blast pressure.		Iron running in—	Weight of iron.			Melting.				Recovered.	
	On at—	Maximum.		Poured.	Additional melted.	Total.	Time.	Rate per hour.	Ratio iron to coke.	Loss.	Iron.	Coke.
		Oz.	*Mins.*	*Lbs.*	*Lbs.*	*Lbs.*	*Mins.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
112	(a)	7										
141	8.05 a. m.	7	5	749	296	1,045	30	2,090	4.48	4.90	1,808	197

a Blast on 30 minutes; no iron melted. Coke very high in ash, and dirty.

LADLE RECORD.

Ladle No.	Test 141.		Ladle No.	Test 141.	
	Pounds.	Time (a. m.).		Pounds.	Time (a. m.).
1	36	8.18	8	57	8.32½
2	78	8.23	9	45	8.33
3	88	8.24	10	55	8.36
4	78	8.28	11	51	8.36½
5	69	8.28½	12	24	8.37
6	40	8.29	13	56	8.39
7	57	8.32	14	15	8.40

Remarks.—Test, 141: Iron cold.

TENNESSEE NO. 7.

Bituminous coal from Wilder, Fentress County, on the Southern Railway, was designated Tennessee No. 7. The coal, as worked from the outcrop at this place, averages 4 feet 4 inches in thickness.

Two samples of coal were shipped from this mine, both inspected by John W. Groves. Tennessee No. 7 A consisted of run-of-mine screened over a ¼-inch by 1-inch shaker screen, and was used in making steaming tests 372, 373, and 374 and producer-gas test 108. Tennessee No. 7 B consisted of slack coal through a plate perforated with ¼-inch by 1-inch holes, and was used in making steaming test 406 (on briquets); washing test 156; coking tests 121 (raw) and 123 (washed); cupola tests 113 and 137; and briquetting test 121.

Two mine samples were taken for chemical analysis. Sample 2979 was taken 2,000 feet north of the drift mouth, where the coal measured 4 feet 7 inches in thickness. Sample 2980 was taken 1,500 feet east of the drift mouth, where the coal measured 4 feet ½ inch in thickness.

CHEMICAL ANALYSES.

Tennessee No. 7.

	Mine samples.		Car sample.[a]	Steaming tests.[b]			
				372.	373.	374.	406.
Laboratory No	2979	2980	3133				
Air-drying loss	2.00	1.80	1.70				
Proximate:							
Moisture	3.46	3.04	3.03	2.98	3.06	3.36	3.37
Volatile matter	34.73	36.37	34.91	34.46	34.30	33.62	35.80
Fixed carbon	52.73	50.46	49.21	49.58	48.49	49.45	50.77
Ash	9.08	10.13	12.85	12.98	14.15	13.57	10.06
Sulphur	2.42	3.84	3.26	3.35	4.18	3.34	2.09
Ultimate:							
Hydrogen			5.03	4.83	4.70	4.79	5.02
Carbon			69.26	71.23	69.47	70.67	75.58
Nitrogen			1.27	1.31	1.27	1.29	1.36
Oxygen			8.33	5.79	5.65	5.75	5.47
Ash				13.39	14.60	14.04	10.41
Sulphur				3.45	4.31	3.46	2.16
Calorific value (as received):							
Determined—calories	7,213		7,001				
Determined—B. t. u.	12,983		12,602				
Calculated from ultimate analysis—calories			7,045				
Calculated from ultimate analysis—B. t. u.			12,681				

[a] Sample from producer-gas test 108 treated as car sample.
[b] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Tennessee No. 7.

	A.			B.
	Test 372.	Test 373.[a]	Test 374.	Test 406.
Size as used:				
Over 1 inch—per cent	51.6	26.1	47.3	See p. 247
½ inch to 1 inch—do	22.6	37.5	20.4	
¼ inch to ½ inch—do	12.4	18.5	12.6	
Under ¼ inch—do	13.4	17.9	19.7	
Duration of test—hours	9.98	9.93	9.95	6.15
Heating value of fuel—B. t. u. per pound dry fuel	12,965	12,681	12,866	13,547
Force of draft:				
Under stack damper—inch water	0.48	0.69	0.49	0.64
Above fire—do	.15	.23	.15	.17
Furnace temperature—°F.	2,660	2,958	2,461	2,420
Dry fuel used per square foot of grate surface per hour—pounds	20.94	26.76	18.45	20.91
Equivalent water evaporated per square foot of water-heating surface per hour—pounds	3.59	4.53	3.26	3.85
Percentage of rated horsepower of boiler developed	100.7	127.1	91.4	108.0
Water apparently evaporated per pound of fuel as fired—pounds	7.04	6.93	7.22	7.66
Water evaporated from and at 212° F.:				
Per pound of fuel as fired—do	8.33	8.23	8.56	8.92
Per pound of dry fuel—do	8.59	8.49	8.86	9.23
Per pound of combustible—do	10.11	10.06	10.48	10.42
Efficiency of boiler, including grate—per cent	63.98	64.65	66.50	65.80
Fuel as fired:				
Per indicated horsepower hour—pounds	3.39	3.44	3.30	3.17
Per electrical horsepower hour—do	4.19	4.24	4.08	3.91
Dry fuel:				
Per indicated horsepower hour—do	3.29	3.33	3.19	3.06
Per electrical horsepower hour—do	4.06	4.11	3.94	3.78

[a] Maximum capacity test.

Remarks.—Test 406 on briquets from test 121. The briquets burned with a long flame, cracked open to a depth of three-fourths of an inch, coked, and held together well until entirely consumed. No smoke; very little clinker; reddish-brown ash.

PRODUCER-GAS TEST.

Tennessee No. 7 A (run of mine).

Test 108.—Duration of test, 50 hours. Average electrical horsepower, 192.5. Average B. t. u. per cubic foot of gas, 154.6. Total coal fired, 14,400 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.60	1.55	1.35
Developed at switchboard	1.50	1.45	1.26
Per brake horsepower:			
Commercially available	1.36	1.32	1.14
Developed at engine	1.27	1.23	1.07
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.74	1.69	1.46
Developed at switchboard	1.63	1.58	1.37
Per brake horsepower:			
Commercially available	1.48	1.43	1.24
Developed at engine	1.38	1.35	1.16

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	11.2
Carbon monoxide (CO)	17.4
Hydrogen (H_2)	15.3
Methane (CH_4)	2.3
Nitrogen (N_2)	53.3
Ethylene (C_2H_4)	.5

WASHING AND COKING TESTS.

Tennessee No. 7 B (slack).

Washing test 156.—Jig used, Stewart. Raw coal, 31,000 pounds; washed coal, 21,000 pounds; refuse, 10,000 pounds.

Coking tests.

		Test 121 (raw).	Test 123 (w.).
Size as used		f. c.	f. c.
Duration of test	hours	46	50
Coal charged	pounds	12,000	12,000
Coke produced	do	6,680	6,911
	per cent	55.67	57.59
Breeze produced	pounds	716	323
	per cent	5.97	2.69
Total yield	do	61.64	60.28

Remarks.—Test 121: Poor coke, soft and punky; coal high in ash and sulphur; might be improved by washing. Test 123: Light gray and silvery, with good ring; great improvement over raw charge; sulphur still too high.

Analyses.

	Washing test 156.		Coking test 121.		Coking test 123.	
	Raw coal.	Washed coal.	Coal.	Coke.	Coal.	Coke.
Moisture	7.88	7.04	7.88	0.43	8.37	0.57
Volatile matter	28.28	.....	28.28	.36	32.29	.87
Fixed carbon	46.43	.....	46.43	74.43	49.02	83.59
Ash	17.41	10.12	17.41	24.78	10.32	14.97
Sulphur	3.43	2.26	3.43	2.98	2.21	1.77

[a] For analyses of fuel used see p. 245 (sample 3133).

Cupola tests of coke made from Tennessee No. 7 B coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
113	123	1.93	7	98.61	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750
137	123	1.93	7	95.83	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750

[a] Sulphur in ash, 0.04 per cent. Phosphorus in coke, 0.0468 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Maximum.	Iron running in—	Weight of iron. Poured.	Additional melted.	Total.	Melting. Time.	Rate per hour.	Ratio iron to coke.	Loss.	Recovered. Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
113	3.30 p. m.	7	8	2,384	132	2,516	30	5,032	8.70	12.06	122	141
137	10.30 a. m.	6½	9	1,446	444	1,890	34	3,336	6.26	5.60	942	128

LADLE RECORD.

Ladle No.	Test 113. Pounds.	Time (p. m.).	Test 137. Pounds.	Time (a. m.).	Ladle No.	Test 113. Pounds.	Time (p. m.).	Test 137. Pounds.	Time (a. m.).
1	93	3.47	88	10.48	14	105	4.03	63	11.02
2	56	3.47½	96	10.48½	15	87	4.03½	35	11.03
3	102	3.51½	61	10.49	16	94	4.04	86	11.06
4	93	3.52	76	10.53	17	105	4.05	61	11.07
5	78	3.56	88	10.53½	18	88	4.05½	67	11.12
6	102	3.56½	93	10.54	19	90	4.06	84	11.13
7	83	3.57	67	10.55	20	106	4.07	.....	.....
8	71	3.59	70	10.55½	21	83	4.07½	.....	.....
9	106	3.59½	76	10.56½	22	90	4.08	.....	.....
10	97	4.00	97	10.57	23	106	4.08½	.....	.....
11	87	4.01	92	10.58	24	84	4.09	.....	.....
12	110	4.01½	100	10.59½	25	96	4.09½	.....	.....
13	93	4.02	46	11.01	26	79	4.11	.....	.....

Remarks.—Test 113: Iron very hot and fluid. Blast off, 3 minutes. Test 137: Iron cold.

BRIQUETTING TEST.

Tennessee No. 7 B (washed slack).

Test 121.—Size as used: Over ¼ inch, 1.8 per cent; $\frac{1}{10}$ inch to ¼ inch, 10.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 19 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 21 per cent; through $\frac{1}{40}$ inch, 47.4 per cent. Machine used, English. Temperature of briquets, 179.6° F. Kind of binder, water-gas pitch; laboratory No. 3410 (see p. 40). Amount of binder, 5.5, 6, 6.5, and 7 per cent. Weight of fuel briquetted, 7,000 pounds; average weight of briquets, 3.08 pounds. B. t. u. per pound of coal as received, 12,447; per pound of briquets as fired, 13,090; per pound of binder, 16,478. Weathering test: Days exposed, 200; condition, B. For analyses of briquets see page 245 (steaming test 406).

Briquets with 5.5 and 6 per cent of binder had firm edges, but surfaces were slightly crumbly when rubbed; broke with a clean fracture, leaving a firm surface; those with 6.5 and 7 per cent of binder had hard and smooth surfaces; fracture hard and firm. Not enough coal was furnished to make tests on Renfrow machine or steaming tests on unbriquetted fuel.

Drop test.

Percentage of binder	5.5	6	6.5	7
Held by 1-inch screen	78.3	79.9	89.5	95.2
Passed 1-inch screen	21.7	20.1	10.5	4.8

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 121.
Laboratory No	3410		
Air-drying loss, per cent		6.10	1.80
Extracted by CS_2:			
Air-dried, do		1.96	6.16
As received, do	79.98	1.84	6.05
Pitch in briquets as received, do			5.39

TENNESSEE NO. 8.

Bituminous coal from Clifty, White County, on the Nashville, Chattanooga and St. Louis Railway, was designated Tennessee No. 8. The coal, as worked from the outcrop at this place, averages 3 feet 6 inches in thickness.

Two lots of coal were shipped from this mine, both inspected by John W. Groves. Tennessee No. 8 A consisted of "special run of mine," which is made by passing coal over a ¾-inch screen and returning about 8 per cent slack to the sample. Tennessee No. 8 B consisted of "screened run of mine," which was passed over a ¾-inch screen and had about 18 per cent of slack returned to it. These samples were used mixed in making steaming tests 384 (raw), 385 (raw), and 388 (washed); producer-gas tests (washed) 116 and 119; washing test 157; coking test 134 (washed coal), and cupola tests 114 and 135.

Two mine samples were taken for chemical analysis. Sample 3005 was taken 2,100 feet north of the drift mouth, where the coal measured 3 feet ¾ inch in thickness. Sample 3006 was taken 1,900 feet north of the drift mouth, where the coal measured 4 feet in thickness.

CHEMICAL ANALYSES.

Tennessee No. 8.

	Mine samples.		Car samples.		Steaming tests.[a]		
			A.	B.	384.	385.	388.
Laboratory No	3005	3006	3127	3128	.....	.....	.....
Air-drying loss	1.90	2.20	1.60	2.00	.....	.....	.....
Proximate:							
Moisture	3.01	3.23	2.63	3.12	2.40	2.36	2.83
Volatile matter	34.70	32.18	33.51	32.91	32.61	33.60	34.70
Fixed carbon	51.53	53.43	50.44	49.85	50.12	50.72	52.24
Ash	10.76	11.16	13.42	14.12	14.87	13.32	10.23
Sulphur	3.42	3.58	4.38	4.74	5.28	4.32	2.92
Ultimate:							
Hydrogen	.....	.....	4.89	4.68	4.41	4.74	5.00
Carbon	.....	.....	69.32	68.20	69.37	71.37	75.31
Nitrogen	.....	.....	1.15	1.23	1.25	1.19	1.25
Oxygen	.....	.....	6.84	7.03	4.32	4.63	4.91
Ash	.....	.....	.....	.....	15.24	13.64	10.53
Sulphur	.....	.....	.....	.....	5.41	4.43	3.00
Calorific value (as received):							
Determined—calories	7,280	.....	7,064	6,954	.....	.....	.....
Determined—B. t. u.	13,104	.....	12,715	12,517	.....	.....	.....
Calculated from ultimate analysis—calories	.....	.....	7,092	6,927	.....	.....	.....
Calculated from ultimate analysis—B. t. u.	.....	.....	12,766	12,469	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Tennessee No. 8 (run of mine).

	Test 384.	Test 385.	Test 388 (w.).
Size as used:			
Over 1 inch, per cent	36.6	37.0	27.5
½ inch to 1 inch, do	28.1	26.1	25.6
¼ inch to ½ inch, do	15.8	14.6	19.4
Under ¼ inch, do	19.5	22.3	27.5
Duration of test, hours	10.02	10.08	10.03
Heating value of coal, B. t. u. per pound dry coal	12,758	13,090	13,532
Force of draft:			
Under stack damper, inch water	0.58	0.62	0.56
Above fire (natural draft), do	.14	.....	.18
In ash pit (forced draft), do	.....	.25	.....
Furnace temperature, ° F.	.....	2,243	2,309
Dry coal used per square foot of grate surface per hour, pounds	15.64	18.40	20.47
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	2.60	3.08	3.78
Percentage of rated horsepower of boiler developed	72.8	86.5	106.1
Water apparently evaporated per pound of coal as fired, pounds	6.87	6.98	7.68
Water evaporated from and at 212° F.:			
Per pound of coal as fired, do	8.12	8.20	8.99
Per pound of dry coal, do	8.32	8.40	9.26
Per pound of combustible, do	10.19	9.94	10.52
Efficiency of boiler, including grate, per cent	62.98	61.97	66.08
Coal as fired:			
Per indicated horsepower hour, pounds	3.48	3.45	3.15
Per electrical horsepower hour, do	4.30	4.26	3.88
Dry coal:			
Per indicated horsepower hour, do	3.40	3.37	3.05
Per electrical horsepower hour, do	4.20	4.16	3.77

PRODUCER-GAS TESTS.

Tennessee No. 8, washed (run of mine).

	Test 116.	Test 119.
Duration of test, hours	50	24
Average electrical horsepower	147.4	197.0
Average B. t. u. per cubic foot of gas	144.6	157.5
Total coal fired, pounds	11,250	6,550

PRODUCER-GAS TESTS—Continued.

Tennessee No. 8, washed (run of mine).

	Test 116.[a]			Test 119.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).						
Per electrical horsepower:						
Commercially available				1.48	1.44	1.30
Developed at switchboard	1.56	1.53	1.37	1.39	1.35	1.22
Per brake horsepower:						
Commercially available				1.26	1.23	1.10
Developed at engine	1.32	1.30	1.16	1.18	1.15	1.03
Equivalent used by producer plant (pounds).						
Per electrical horsepower:						
Commercially available				1.58	1.54	1.39
Developed at switchboard	1.69	1.66	1.48	1.48	1.41	1.30
Per brake horsepower:						
Commercially available				1.34	1.31	1.18
Developed at engine	1.43	1.41	1.26	1.26	1.23	1.10

[a] Without tar extractor.

Analyses.

	Test 116.	Test 119.		Test 116.	Test 119.
Coal.			*Gas by volume.*		
Moisture	1.62	2.43	Carbon dioxide (CO_2)	9.9	9.7
Volatile matter	34.44	35.41	Carbon monoxide (CO)	19.7	19.1
Fixed carbon	53.32	52.29	Hydrogen (H_2)	14.3	15.1
Ash	10.62	9.87	Methane (CH_4)	1.9	2.1
Sulphur	3.05	3.06	Nitrogen (H_2)	53.8	53.5
			Ethylene (C_2H_4)	.4	.5

WASHING AND COKING TESTS.

Tennessee No. 8 (run of mine).

Washing test 157.—Size as used, crushed to 2 inches; jig used, Stewart. Raw coal, 98,000 pounds; washed coal, 86,000 pounds; refuse, 12,000 pounds.

Coking test 134.—Size as used, washed, finely crushed. Duration of test, 45 hours. Coal charged, 12,000 pounds. Coke produced, 6,870 pounds, 57.25 per cent. Breeze produced, 320 pounds, 2.67 per cent. Total yield, 59.92 per cent. Light gray and silvery. Good coke physically, but washing does not reduce sulphur sufficiently.

Analyses.

	Washing test 157.		Coking test 134.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	3.12	1.71	3.09	0.32
Volatile matter	32.91	.....	35.32	.11
Fixed carbon	49.85	.....	51.70	85.66
Ash	14.12	9.99	9.89	13.91
Sulphur	4.74	2.94	2.95	2.45

Cupola tests of coke made from Tennessee No. 8 coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Coke.[a] Specific gravity.	Coke.[a] Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
114	134	1.98	7	93.14	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750
135	134	1.98	7	97.22	Coke	180	63	63	62	62	430
					Pig iron	540	428	428	427	427	2,250
					Scrap	180	143	143	142	142	750

[a] Phosphorus in coke, 0.0238 per cent.

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
114	11.05 a. m.	7	7	2,301	217	2,518	36	3,918	6.92	8.36	231	66
135	9.47 a. m.	7	7	1,547	1,034	2,581	27	5,956	6.59	8.33	169	38

LADLE RECORD.

Ladle No.	Test 114. Pounds.	Test 114. Time (a. m.).	Test 135. Pounds.	Test 135. Time (a. m.).	Ladle No.	Test 114. Pounds.	Test 114. Time (a. m.).	Test 135. Pounds.	Test 135. Time (a. m.).
1	61	11.18	30	9.56	15	95	11.34	73	10.14
2	92	11.24	72	9.58	16	64	11.34½	74	10.15
3	105	11.24½	102	10.00	17	78	11.36	82	10.17
4	64	11.25	75	10.01	18	103	11.36½	107	10.17½
5	74	11.27	87	10.04	19	96	11.37	76	10.18
6	98	11.27½	87	10.04½	20	77	11.37½	111	10.21
7	87	11.28	84	10.06½	21	92	11.38½	.....	.....
8	78	11.28½	78	10.07	22	74	11.39	.....	.....
9	61	11.30	21	10.07½	23	83	11.39½	.....	.....
10	83	11.30½	89	10.09	24	104	11.40	.....	.....
11	101	11.31	80	10.11½	25	57	11.46½	.....	.....
12	109	11.31½	85	10.12	26	67	11.47	.....	.....
13	104	11.33	65	10.12½	27	104	11.48	.....	.....
14	90	11.33½	69	10.13½					

Remarks.—Test 114: Iron very hot. Test 135: Iron hot. Blast off 1 minute; top hole cut out and iron run over trough.

TENNESSEE NO. 9.

Bituminous coal from Coalmont, Grundy County, on the Nashville, Chattanooga and St. Louis Railway, was designated Tennessee No. 9. The coal, as worked from the outcrop at this place, averages 3 feet 4 inches in thickness.

One car of coal was shipped from this mine under the supervision of John W. Groves. Twenty tons of lump, over a ¾-inch screen, designated A, was used in making steaming tests 363, 364, and 365.

Ten tons of slack, designated B, was used in making washing test 158; and this coal, washed, in addition to 14 tons of slack, designated C, as shipped, was used in making steaming test (on briquets) 393; also in coking test 124, cupola tests 110 and 136, and briquetting test 122.

Two mine samples were taken for chemical analysis. Sample 2995 was taken 1,900 feet north of the drift mouth, where the coal measured 3 feet in thickness. Sample 2996 was taken 2,000 feet south of the drift mouth, where the coal measured 3 feet 6 inches in thickness.

CHEMICAL ANALYSES.

Tennessee No. 9.

	Mine samples.		Car samples.			Steaming tests.[a]			
						A.			B and C
			A.	B.	C.	363.	364.	365.	393.
Laboratory No.	2995	2996	3113	3114	3115	.....	.....	.....	.....
Air-drying loss	2.30	2.40	2.60	4.70	3.30	.....	.....	.....	.....
Proximate:									
Moisture	3.44	3.77	3.92	5.68	4.68	4.46	3.48	3.60	4.24
Volatile matter	29.24	28.60	27.23	25.36	28.75	27.36	27.86	28.40	29.80
Fixed carbon	58.11	59.46	54.76	50.41	57.31	55.70	56.34	53.26	56.10
Ash	9.21	8.17	14.09	18.55	9.26	12.48	12.32	14.74	9.86
Sulphur	.73	.68	.94	.74	.65	1.01	.79	.78	.79
Ultimate:									
Hydrogen	.....	.....	4.81	5.02	5.04	4.63	4.66	4.52	4.60
Carbon	.....	.....	69.97	64.58	73.85	74.13	74.62	72.43	77.00
Nitrogen	.....	.....	1.29	1.20	1.24	1.37	1.38	1.34	1.43
Oxygen	.....	.....	8.90	9.91	9.96	5.75	5.76	5.61	5.84
Ash	.....	.....	.....	.....	.....	13.06	12.76	15.29	10.30
Sulphur	.....	.....	.....	.....	.....	1.06	.82	.81	.83
Calorific value (as received):									
Determined, calories	7,344	.....	6,949	6,378	7,313	.....	.....	.....	.....
Determined, B. t. u.	13,219	.....	12,508	11,480	13,163	.....	.....	.....	.....
Calculated from ultimate analysis, calories	.....	.....	6,950	6,537	7,288	.....	.....	.....	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	12,510	11,767	13,118	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Tennessee No. 9.

	A.			B and C.
	Test 363.	Test 364.	Test 365.	Test 393.
Size as shipped	¾-in. l.	¾-in. l.	¾-in. l.	
Size as used:				
Over 1 inch, per cent	12.6	13.8	7.1	See p. 254
½ inch to 1 inch, do	24.5	22.4	17.3	
¼ inch to ½ inch, do	24.5	23.8	22.8	
Under ¼ inch, do	38.4	40.0	52.8	
Duration of test, hours	10.0	9.95	9.98	10.13
Heating value of fuel, B. t. u. per pound dry coal	13,257	13,333	12,938	13,613
Force of draft:				
Under stack damper, inch water	0.65	0.70	0.71	0.62
Above fire, do	.15	.19	.24	.23
Furnace temperature, °F.	2,263	2,296	2,284	2,276
Dry fuel used per square foot of grate surface per hour, pounds	19.80	21.90	21.01	21.60
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.51	3.81	3.52	4.07
Percentage of rated horsepower of boiler developed	98.5	106.9	98.8	114.0
Water apparently evaporated per pound of fuel as fired, pounds	7.21	7.20	6.92	7.71
Water evaporated from and at 212° F.:				
Per pound of fuel as fired, pounds	8.50	8.41	8.10	9.03
Per pound of dry fuel, do	8.89	8.71	8.40	9.43
Per pound of combustible, do	10.47	10.15	10.16	10.62

STEAMING TESTS—Continued.

Tennessee No. 9.

	A.			B and C.
	Test 363.	Test 364.	Test 365.	Test 393.
Efficiency of boiler, including grate.....per cent..	64.76	63.09	62.70	66.90
Fuel as fired:				
Per indicated horsepower hour.....pounds..	3.33	3.36	3.49	3.13
Per electrical horsepower hour.....do....	4.11	4.15	4.31	3.87
Dry fuel:				
Per indicated horsepower hour.....do....	3.18	3.25	3.37	3.00
Per electrical horsepower hour.....do....	3.93	4.01	4.16	3.70

Remarks.—Test 393 on briquets, which were very firm and burned freely, with long flame and without smoke. They swelled in the fire and then fell to pieces. Nearly all of the briquets were fired whole. Clinker solid, heavy and brittle, and of a light-brown color.

WASHING AND COKING TESTS.

Tennessee No. 9.

Washing test 158 (*coal B, slack*).—Jig used, Stewart. Raw coal, 19,385 pounds; washed coal, 14,420 pounds; refuse, 4,965 pounds.

Coking test 124 (*coals B and C, slack*).—Size as used: Finely crushed. Duration of test, 49 hours. Coal charged, 12,000 pounds. Coke produced, 7,948 pounds; 66.23 per cent. Breeze produced, 283 pounds; 2.36 per cent. Total yield, 68.59 per cent. Light gray with some little deposit of carbon. Good coke.

Analyses.

	Washing test 158.		Coking test 124.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	5.68	4.02	4.02	0.39
Volatile matter	25.36	27 79	27.79	.39
Fixed carbon	50.41	58.28	58.28	85.78
Ash	18.55	9.91	9.91	13.44
Sulphur	.74	.85	.85	.61

Cupola tests of coke made from Tennessee Nos. 9 B and 9 C coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
					Coke	190	60	60	60	60	430
110	124	1.93	7	99.9	Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750
					Coke	200	58	58	57	57	430
136	124	1.93	7	93.05	Pig iron	600	413	413	412	412	2,250
					Scrap	200	138	138	137	137	750

[a] Sulphur in ash, 0.04 per cent. Phosphorus in coke, 0.0968 per cent.

Cupola tests of coke made from Tennessee Nos. 9 B and 9 C coal (washed)—Continued.

RECORD OF MELT.

Cupola test No.	Blast pressure.		Iron running in—	Weight of iron.			Melting.				Recovered.	
	On at—	Maximum.		Poured.	Additional melted.	Total.	Time.	Rate per hour.	Ratio iron to coke.	Loss.	Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
110	3.27 p. m....	6½	6	1,950	110	2,060	34	3,635	6.28	6.83	735	102
136	3.41 p. m....	7	7	2,106	250	2,356	26	5,437	6.83	1.13	615	85

LADLE RECORD.

Ladle No.	Test 110.		Test 136.		Ladle No.	Test 110.		Test 136.	
	Pounds.	Time (p. m.).	Pounds.	Time (p. m.).		Pounds.	Time (p. m.).	Pounds.	Time (p. m.).
1	46	3.37	96	3.57	13	97	3.54	107	4.06½
2	86	3.42	110	3.57½	14	87	3.57½	88	4.07
3	103	3.42½	43	3.58	15	100	3.58	84	4.07½
4	24	3.43	77	3.59	16	105	3.59	100	4.09
5	95	3.45½	103	4.00	17	88	4.01	93	4.09½
6	100	3.46	111	4.00½	18	98	4.02	84	4.10
7	101	3.47	30	4.01	19	93	4.02½	91	4.10½
8	94	3.49	88	4.01½	20	86	4.05½	109	4.11
9	103	3.49½	101	4.03	21	91	4.06	92	4.11½
10	55	3.50	104	4.03½	22	98	4.07.	108	4.13
11	96	3.53	72	4.04	23	.....	.....	57	4.13½
12	104	3.53½	93	4.06	24	.....	.....	65	4.14

Remarks.—Test 110: Iron very hot and fluid.

BRIQUETTING TEST.

Tennessee Nos. 9 B and 9 C (washed slack).

Test 122.—Size as used: Over ¼ inch, 1.2 per cent; $\frac{1}{10}$ inch to ¼ inch, 5.5 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 12.5 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 23.8 per cent; through $\frac{1}{40}$ inch, 57 per cent. Machine used, English. Temperature of briquets, 179.6° F. Kind of binder, water-gas pitch; laboratory No. 3410 (see p. 40). Weight of fuel briquetted, 14,400 pounds; average weight of briquets, 3.24 pounds. B. t. u. per pound of coal as received, 13,163; per pound of briquets as fired, 13,047; per pound of binder, 16,478. For analyses of briquets see page 252 (steaming test 393).

With 5.4 and 5.6 per cent binder, briquets were fairly good, but somewhat crumbly at edges. With 6.6, 7, and 8 per cent binder, outer surfaces were very firm and smooth, fracture coarse, but not crumbly; broken surfaces very hard. In drop test, with 7 per cent binder, the 1-inch screen held 85.6 per cent and passed 14.4 per cent. Weathering test: All binders exposed 222 days; condition, B. Not enough coal was furnished to make briquets on Renfrow machine for comparative tests.

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 122.
Laboratory No.	3410	3338	.....
Air-drying loss.....per cent.	.....	4.7	2.5
Extracted by CS_2:			
Air-dried.....do....	.....	.2	5.45
As received.....do....	79.98	.19	5.31
Pitch in briquets as received.....do....	.....	.....	6.41

TENNESSEE NO. 10.

Bituminous coal from a mine located 1 mile north of Orme, Marion County, on the Nashville, Chattanooga and St. Louis Railway, was designated Tennessee No. 10. This coal, as worked from the outcrop at this place, averages 5 feet 8 inches in thickness.

This sample, consisting of slack coal shipped under the supervision of W. J. Von Borries, was used in making steaming tests (on briquets) 407 and 408, washing test 173, coking test 156, cupola tests 111 and 127, and briquetting test 128.

Two mine samples were taken for chemical analysis. Sample 3009 was taken 2,200 feet northeast of the opening, where the coal measured 5 feet 8 inches in thickness. Sample 3010 was taken 2,500 feet northwest of the opening, where the coal measured 5 feet 8 inches in thickness.

CHEMICAL ANALYSES.

Tennessee No. 10.

	Mine samples.		Steaming tests.[a]	
			407.	408.
Laboratory No	3009	3010	.....	.....
Air-drying loss	2.00	2.00	.....	.....
Proximate:				
Moisture	3.31	3.37	2.46	2.88
Volatile matter	31.71	32.38	30.89	30.84
Fixed carbon	51.87	53.13	51.80	49.55
Ash	13.11	11.12	14.85	16.73
Sulphur	1.30	.65	1.02	.96
Ultimate:				
Hydrogen	.....	.....	4.47	4.56
Carbon	.....	.....	71.53	69.82
Nitrogen	.....	.....	1.30	.92
Oxygen	.....	.....	6.43	6.48
Ash	.....	.....	15.22	17.23
Sulphur	.....	.....	1.05	.99
Calorific value determined (as received) calories	6,774	.....	.....	.....
Calorific value determined (as received) B. t. u.	12,193	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Tennessee No. 10 (washed briquets).

	Test 407.	Test 408.
Duration of test, hours	4.72	3.87
Heating value of fuel, B. t. u. per pound dry fuel	12,667	12,272
Force of draft:		
Under stack damper, inch water	0.68	0.68
Above fire, do	.18	.15
Furnace temperature, °F.	[a]1,184	2,226
Dry fuel used per square foot of grate surface per hour, pounds	18.05	19.28
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	2.80	3.32
Percentage of rated horsepower of boiler developed	78.6	93.1
Water apparently evaporated per pound of fuel as fired, pounds	6.53	7.21
Water evaporated from and at 212° F.:		
Per pound of fuel as fired, do	7.58	8.38
Per pound of dry fuel, do	7.77	8.63
Per pound of combustible, do	9.42	10.83
Efficiency of boiler, including grate, per cent	59.24	67.91
Fuel as fired:		
Per indicated horsepower hour, pounds	3.73	3.37
Per electrical horsepower hour, do	4.61	4.17
Dry fuel:		
Per indicated horsepower hour, do	3.64	3.28
Per electrical horsepower hour, do	4.49	4.05

[a] Average is not representative of test. In one-third of the observations the temperature was too low to be read by Wanner optical pyrometer.

Remarks.—Tests made on English briquets, which were broken in two before firing. They cracked open to a depth of 1½ inches, but coked and kept their shape until entirely consumed. No smoke. Ash and clinker were brown.

WASHING AND COKING TESTS.

Tennessee No. 10 (1-inch slack).

Washing test 173.—Jig used, Stewart. Raw coal, 60,500 pounds; washed coal, 47,400 pounds; refuse, 13,100 pounds.

Coking test 156.—Size as used: Washed, finely crushed. Duration of test, 53 hours. Coal charged, 11,690 pounds. Coke produced, 6,900 pounds; 59.02 per cent. Breeze produced, 757 pounds; 6.48 per cent. Total yield, 65.50 per cent. Poor coke; soft and dense; heavy black butt; practically no cell structure; high ash.

Analyses.

	Washing test 173.		Coking test 156.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	2.92	7.02	7.80	1.67
Volatile matter	.....	.....	29.29	.81
Fixed carbon	.....	.....	49.32	77.81
Ash	22.74	3.75	13.59	19.71
Sulphur	.95	.98	1.05	.95

Cupola tests of coke made from Tennessee No. 10 coal (washed).

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
					Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
111	156	1.90	7	Coke	230	50	50	50	50	430
				Pig iron	690	390	390	390	390	2,250
				Scrap	230	130	130	130	130	750
127	156	1.90	.....	Coke	250	.....	.....	.....	.....	.....

[a] Phosphorus in coke, 0.0390 per cent.

Remarks.—Test 111: Blast on from 10.51 a. m. for 30 minutes, at maximum pressure of 7 ounces; no iron melted. Test 127: Coke bed put in and blast put on for 20 minutes; coke would not ignite; bottom dropped without charging iron.

BRIQUETTING TEST.

Tennessee No. 10 (1-inch slack, washed).

Test 128.—Kind of binder, water-gas pitch; laboratory No. 3410 (see p. 40). Weight of fuel briquetted, 35,400 pounds. B. t. u. per pound of coal from car sample, 11,596; per pound of briquets as fired, 11,920; per pound of binder, 16,478. The briquets made with the three percentages of pitch (5.5, 6.5, and 6.7) were all good.

English briquets made at 175° F., average weight 3.63 pounds, with 5.5 per cent binder, could be roughened slightly by rubbing; outer surfaces crumbled slightly when broken. Briquets with 6 and 6.5 per cent binder could be roughened slightly by rubbing; outer surfaces hard and smooth; broken surfaces very hard and rough. In the drop test of English briquets with 5.5 per cent binder the 1-inch screen held 81.7 per cent and passed 18.3 per cent; with 6 per cent binder the screen held 90.1

per cent and passed 9.9 per cent; with 6.5 per cent binder the screen held 89.1 per cent and passed 10.9 per cent. In the weathering test all briquets were exposed 203 days, condition B. For analyses of briquets see page 255 (steaming tests 407 and 408).

Renfrow briquets made at 149° F., average weight 0.53 pound, with 6 per cent binder, showed crumbly, fractured surfaces. With 6.5 per cent binder briquets were tougher and did not break as easily, and broken surfaces were firm, but still appeared short on pitch. In the weathering test briquets with both binders were exposed 204 days; condition B.

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 128.
Laboratory No.	3410	3359	.....
Air-drying loss.....per cent.	.....	5.20	1.3
Extracted by CS_2:			
Air-dried.....do....	.....	1.39	7.07
As received.....do....	79.98	1.32	6.98
Pitch in briquets as received.....do....	.....	.....	7.19

TENNESSEE NO. 11.

Bituminous coal from Ozone, Cumberland County, on the Tennessee Central Railway was designated Tennessee No. 11.

This sample consisted of slack coal through 1¼-inch bar screen. It was shipped without inspection, as additional samples of the run-of-mine coal are to be obtained later when an inspector will be sent to the mine and mine samples taken. The following tests were made on this coal: Washing test 178, coking test 160 (washed coal), and cupola tests 144 and 179.

CHEMICAL ANALYSES.

Tennessee No. 11.

	Car sample.		Car sample.
Laboratory No.	3471	Ultimate:	
Air-drying loss	2.30	Hydrogen	4.13
Proximate:		Carbon	59.07
Moisture	3.53	Nitrogen	1.10
Volatile matter	20.75	Oxygen	6.83
Fixed carbon	47.85	Calorific value (as received):	
Ash	27.87	Determined.....calories..	5,702
Sulphur	.90	.....B. t. u...	10,264
		Calculated from ultimate analysis.....calories..	5,931
		.....B. t. u...	10,676

WASHING AND COKING TESTS.

Tennessee No. 11 (slack).

Washing test 178.—Jig used, Stewart. Raw coal, 42,000 pounds; washed coal, 27,500 pounds; refuse, 14,500 pounds.

Coking test 160.—Size as used: Washed, finely crushed. Duration of test, 40 hours; coal charged, 11,890 pounds; coke produced, 7,650 pounds; 64.34 per cent. Breeze

produced, 550 pounds; 4.63 per cent. Total yield 68.97 per cent. Poor, dense coke; ash very high.

Analyses.

	Washing test 178.		Coking test 160.	
	Raw coal.	Washed coal.	Coal.	Coke.
Moisture	3.53	5.60	5.29	1.14
Volatile matter	20.75	.....	23.61	1.60
Fixed carbon	47.85	.....	56.58	80.14
Ash	27.87	13.47	14.52	17.12
Sulphur	.90	.92	.86	.69

Cupola tests of coke made from Tennessee No. 11 coal (washed).

CHARGE.

Cupola test No.	Coke. Test No.	Coke. Specific gravity.	Coke. Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
144	160	1.97	7	.....	Coke	240	48	48	47	47	430
					Pig iron	960	510	510	510	510	3,000
179	160	1.97	7	86.11	Coke	220	53	53	52	52	430
					Pig iron	660	398	398	397	397	2,250
					Scrap	220	133	133	132	132	750

RECORD OF MELT.

Cupola test No.	Blast pressure. On at—	Blast pressure. Maximum.	Iron running in—	Weight of iron. Poured.	Weight of iron. Additional melted.	Weight of iron. Total.	Melting. Time.	Melting. Rate per hour.	Melting. Ratio iron to coke.	Melting. Loss.	Recovered. Iron.	Recovered. Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
144	10.50 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
179	11.28 a. m.	6	16	424	317	741	20	2,223	2.58	2.03	2,189	143

LADLE RECORD.

Ladle No.	Test 179. Pounds.	Test 179. Time (a. m.).	Ladle No.	Test 179. Pounds.	Test 179. Time (a. m.).
1	84	11.51	4	92	11.57
2	41	11.52	5	55	12.03
3	75	11.56	6	77	12.04

Remarks.—Test 144. Blast on 32 minutes; no iron melted; all pig iron used to determine effect of sulphur. Test 179: Iron cold and sluggish.

TEXAS.

TEXAS NO. 3.

Lignite from Olsen, Milan County, on the International and Great Northern Railroad, was designated Texas No. 3. The lignite, as worked at a depth of 63 feet at this place, averages 6 feet 6 inches in thickness.

This sample was shipped under the supervision of W. J. Von Borries. It consisted of lump lignite over a ¾-inch screen and was used in making producer-gas test 93.

Two mine samples were taken for chemical analysis. Sample 2562 was taken 400 feet east of the shaft where the coal measured 6 feet 5 inches in thickness. Sample 2563 was taken 500 feet east of the shaft, where the coal measured 6 feet 7 inches in thickness.

CHEMICAL ANALYSES.

Texas No. 3.

	Mine samples.		Car sample.		Mine samples.		Car sample.
Laboratory No.	2562	2563	2734	Ultimate—Continued.			
Air-drying loss	29.10	20.00	23.50	Nitrogen			0.90
Proximate:				Oxygen			39.00
Moisture	36.01	35.56	31.06	Calorific value (as received):			
Volatile matter	27.95	28.91	27.67	Determined calories	3,962		4,372
Fixed carbon	28.66	27.49	33.39	Determined B. t. u.	7,132		7,870
Ash	7.38	8.04	7.88	Calculated from ultimate analysis calories			4,203
Sulphur	.77	.75	.99	Calculated from ultimate analysis B. t. u.			7,565
Ultimate:							
Hydrogen			6.53				
Carbon			44.70				

PRODUCER-GAS TEST.

Texas No. 3 (lump).

Test 93.—Size as used: Over 1 inch, 61 per cent; ½ inch to 1 inch, 18 per cent; ¼ inch to ½ inch, 8 per cent; under ¼ inch, 13 per cent. Duration of test, 50 hours. Average electrical horsepower, 200.1. Average B. t. u. per cubic foot of gas, 171.8. Total coal fired, 25,500 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.70	1.83	1.59
Developed at switchboard	2.55	1.73	1.50
Per brake horsepower:			
Commercially available	2.29	1.55	1.35
Developed at engine	2.17	1.47	1.28
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.90	1.97	1.71
Developed at switchboard	2.75	1.86	1.62
Per brake horsepower:			
Commercially available	2.47	1.67	1.46
Developed at engine	2.33	1.58	1.38

Analyses.

Coal.		*Gas by volume.*	
Moisture	32.20	Carbon dioxide (CO_2)	10.3
Volatile matter	30.11	Carbon monoxide (CO)	19.8
Fixed carbon	28.82	Hydrogen (H_2)	14.8
Ash	8.87	Methane (CH_4)	2.4
Sulphur	0.88	Nitrogen (N_2)	51.3
		Oxygen (O_2)	.7
		Ethylene (C_2H_4)	.7

TEXAS NO. 4.

Lignite from Hoyt, Wood County, on the Missouri, Kansas and Texas Railway was designated Texas No. 4. The coal, as worked at a depth of 45 feet at this place, averages 7 feet in thickness.

This sample was shipped under the supervision of W. J. Von Borries. It consisted of run-of-mine coal and was used in making steaming tests 291, 298, and 303; producer-gas test 92, and briquetting test 112.

Two mine samples were taken for chemical analysis. Sample 2635 was taken 1,100 feet southeast of the slope, where the coal measured 6 feet 6 inches in thickness. Sample 2636 was taken 400 feet north of the slope, where the coal measured 8 feet in thickness.

CHEMICAL ANALYSES.

Texas No. 4.

	Mine samples.		Car sample.	Steaming tests.[a]		
				291.	298.	303.
Laboratory No.	2635	2636	2717			
Air-drying loss	29.90	28.40	26.70			
Proximate:						
Moisture	36.80	34.87	33.85	36.27	36.30	33.43
Volatile matter	28.86	29.80	27.50	30.58	30.61	37.80
Fixed carbon	28.09	27.69	31.35	25.14	24.90	18.17
Ash	6.25	7.64	7.30	8.01	8.19	10.60
Sulphur	.53	.50	.51	.51	.50	.68
Ultimate:						
Hydrogen			6.68	4.33	4.32	4.31
Carbon			43.12	64.02	63.83	63.72
Nitrogen			.71	1.05	1.05	1.05
Oxygen			41.68	17.23	17.15	17.14
Ash				12.57	12.86	12.95
Sulphur				.80	.79	.83
Calorific value (as received):						
Determined (calories)	3,945		4,165			
Determined (B. t. u.)	7,101		7,497			
Calculated from ultimate analysis (calories)			4,002			
Calculated from ultimate analysis (B. t. u.)			7,204			

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Texas No. 4 (run of mine).

	Test 291.	Test 298.	Test 303.
Size as used:			
Over 1 inch, per cent		44.2	14.7
½ inch to 1 inch, do		21.7	15.2
¼ inch to ½ inch, do		14.0	14.7
Under ¼ inch, do		20.1	55.4
Duration of test, hours	10.18	7.15	[a] 4.32
Kind of grate		Rocking.	Rocking.
Heating value of coal, B. t. u. per pound dry coal	11,131	11,099	11,077
Force of draft:			
Under stack damper, inch water	0.70	0.61	0.65
Above fire, do		.19	(b)
In ash pit, do	.49		
Furnace temperature, °F	2,119	2,269	2,299
Dry coal used per square foot of grate surface per hour, pounds	23.06	35.22	34.15
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.18	3.71	3.44
Percentage of rated horsepower of boiler developed	89.1	104.1	96.4
Water apparently evaporated per pound of coal as fired, pounds	3.68	3.11	3.81

[a] Too short for reliable results. [b] Forced draft.

STEAMING TESTS—Continued.

Texas No. 4 (run of mine).

	Test 291.	Test 298.	Test 303.
Water evaporated from and at 212° F.:			
Per pound of coal as fired.....do....	4.40	3.75	4.60
Per pound of dry coal.....do....	6.90	5.88	5.62
Per pound of combustible.....do....	8.09	6.86	6.99
Efficiency of boiler, including grate.....per cent..	59.86	51.16	49.00
Coal as fired:			
Per indicated horsepower hour.....pounds..	6.43	7.54	6.15
Per electrical horsepower hour.....do....	7.94	9.32	7.59
Dry coal:			
Per indicated horsepower hour.....do....	4.10	4.81	5.03
Per electrical horsepower hour.....do....	5.06	5.94	6.22

PRODUCER-GAS TEST.

Texas No. 4 (run of mine).

Test 92.—Size as used: Over 1 inch, 68 per cent; ½ inch to 1 inch, 16 per cent; ¼ inch to ½ inch, 7 per cent; under ¼ inch, 9 per cent. Duration of test, 50 hours. Average electrical horsepower, 193.4; average B. t. u. per cubic foot of gas, 156.1; total coal fired, 24,550 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.66	1.75	1.55
Developed at switchboard	2.54	1.67	1.48
Per brake horsepower:			
Commercially available	2.26	1.49	1.32
Developed at engine	2.16	1.42	1.26
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.87	1.89	1.67
Developed at switchboard	2.74	1.81	1.60
Per brake horsepower:			
Commercially available	2.43	1.61	1.42
Developed at engine	2.33	1.54	1.36

Analyses.

Coal.		*Gas by volume.*	
Moisture	34.08	Carbon dioxide (CO_2)	10.3
Volatile matter	33.15	Carbon monoxide (CO)	20.0
Fixed carbon	25.32	Hydrogen (H_2)	15.4
Ash	7.45	Methane (CH_4)	2.5
Sulphur	.49	Nitrogen (N_2)	51.8

BRIQUETTING TEST.

Texas No. 4.

Test 112.—Machine used, English. Temperature of briquets, 179.6° F. Kind of binder, coal-tar pitch; laboratory No. 2933 (see p. 40). Amount of binder, 5, 6, 7, and 8 per cent. Weight of fuel briquetted, 4,500 pounds. B. t. u. per pound of fuel as received, 11,333; per pound of binder, 15,937.

Briquets were of a brown color and full of cracks. The different percentages of binder had no relative effect on the firmness; all fell apart when the pitch hardened. None was satisfactory; did not burn well. They did not swell nor crack, but gradually disintegrated in the fire, burning slowly with characteristic lignite sparking. In the weathering test all briquets were exposed 75 days; condition D.

UTAH.

UTAH NO. 1.

Bituminous coal from prospect on Huntington Creek, Carbon County, was designated Utah No. 1.

Run-of-mine coal was shipped with considerable difficulty and without inspection from this prospect to the testing plant. It was furnished principally for coking tests and no mine samples were taken. The coal was used in making producer-gas test 118, coking test 130, cupola test 118, and briquetting test 126; also mixed with Rhode Island No. 1 in steaming tests (on briquets) 414 and 415 (see p. 223), coking tests 141 and 157, and briquetting test 127.

CHEMICAL ANALYSES.

Utah No. 1.

	Car sample.		Car sample.
Laboratory No	3199	Ultimate:	
Air-drying loss	3.80	Hydrogen	5.76
Proximate:		Carbon	72.32
Moisture	6.05	Nitrogen	1.38
Volatile matter	42.02	Oxygen	15.12
Fixed carbon	47.06	Calorific value (as received):	
Ash	4.87	Determined {calories	7,306
Sulphur	.55	{B. t. u	13,151
		Calculated from ultimate analysis {calories	7,189
		{B. t. u	12,940

PRODUCER-GAS TEST.

Utah No. 1 (run of mine).

Test 118.—Duration of test, 50 hours. Average electrical horsepower, 206.2. Average B. t. u. gas per cubic foot, 171.4. Total coal fired, 14,250 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.46	1.38	1.31
Developed at switchboard	1.38	1.30	1.24
Per brake horsepower:			
Commercially available	1.24	1.17	1.11
Developed at engine	1.17	1.11	1.05

Analyses.

Coal.		*Gas by volume.*	
Moisture	5.83	Carbon dioxide (CO_2)	8.5
Volatile matter	42.46	Carbon monoxide (CO)	22.2
Fixed carbon	47.05	Hydrogen (H_2)	15.7
Ash	4.66	Methane (CH_4)	2.6
Sulphur	.57	Nitrogen (N_2)	50.5
		Ethylene (C_2H_4)	.5

COKING TESTS.

Utah No. 1 (run of mine).

		Test 130.	Test 141.	Test 157.
Size as used		f. c.	f. c.	f. c.
Duration of test	hours	49	60	48
Coal charged	pounds	11,810	12,000	12,000
Coke produced	do	5,550	None.	3,504
	per cent	46.99	.....	29.20
Breeze produced	pounds	1,418	.....	3,208
	per cent	12.01	.....	26.73
Total yield	do	59.00	.....	55.93

Remarks.—Test 130: Dull-gray color; very finely fingered, with practically no cell structure. Test 141: Attempt was made to improve coke from Utah No. 1 by lowering volatile of Utah No. 1 by addition of one-third Rhode Island No. 1 (graphitic), but with no success. Test 157: Mixed with one-fourth Rhode Island No. 1; coke very poor; half did not stick together; other half very poor and finely fingered, as in test 130.

Analyses.

	Test 130.		Coal, test 141.	Test 157.	
	Coal.	Coke.		Coal.	Coke.
Moisture	5.83	2.53	4.08	4.60	1.50
Volatile matter	41.89	1.37	28.43	35.38	1.38
Fixed carbon	47.44	88.06	57.52	53.07	86.07
Ash	4.84	8.04	9.97	6.95	11.05
Sulphur	.56	.64	.45	.46	.57

Cupola test of coke made from Utah No. 1 coal.

CHARGE.

Cupola test No.	Coke.[a]			Materials.	Divisions of charge.					Total.
	Test No.	Specific gravity.	Ratio iron to coke.		1.	2.	3.	4.	5.	
					Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
118	130	1.78	7	Coke	200	58	58	57	57	430
				Pig iron	600	413	413	412	412	2,250
				Scrap	200	138	138	137	137	750

[a] Phosphorus in coke, 0.005 per cent.

Remarks.—Blast on at 10.41 a. m. for 20 minutes at maximum pressure of 7 ounces; no iron melted; bed burned out.

BRIQUETTING TESTS.

Utah No. 1 (run of mine).

Test 126.—Size as used: Over $\frac{1}{4}$ inch, 1.4 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 5.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 14.4 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 25 per cent; through $\frac{1}{40}$ inch, 53 per cent. This coal was briquetted with low percentages of binder, with the idea of utilizing the natural resin (probably copalite) contained in the coal. With 4 and 5 per cent binder the heat in the machine would not melt the natural resin, and the briquets were very short on binder and crumbled badly. With 6 per cent binder the surfaces of whole briquets and of fracture crumbled. The use of a still higher per-

centage of pitch would improve the briquets. No drop tests were made on these briquets and no other regular data were obtained, on account of the small amount of the sample.

Test 127 (with Rhode Island No. 1).—Size as used: Over ¼ inch, 1 per cent; $\frac{1}{10}$ inch to ¼ inch, 5.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 9.4 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 26.4 per cent; through $\frac{1}{40}$ inch, 57.4 per cent. This test was made to prove the value of briquetting a good fuel with one that is commercially worthless. A high volatile coal low in ash was chosen to mix with the graphitic coal. Various percentages were tried, but 47 per cent of each coal and 6 per cent binder made an entirely satisfactory briquet. Six per cent binder made excellent briquets; outer surface smooth and polished, and very hard; briquets broke without crumbling, and broken surfaces were smooth and hard. For analyses of briquets see page 223 (steaming tests 414 and 415).

	Test 126.	Test 127.		Test 126.	Test 127.
Details of manufacture:			Details of manufacture—Continued.		
Machine used	Renf.	Renf.	Heat value per pound—		
Temperature of briquets, ° F	149	149	Fuel as received, B. t. u.	13,151	12,259
Binder—			Fuel as fired .B. t. u.		12,532
Kind	w. g. p.	w. g. p.	Binder.....do....	16,473	16,478
Laboratory No. (see p. 40)	3410	3410	Weathering test:		
Amount...per cent..	4,5,6	6	Time exposed.....days..	214	214
Weight of—			Condition	C	B
Fuel briquetted, pounds	2,000	16,000			
Briquets, average, pounds	0.43	0.5			

Extraction analyses.

	Pitch.	Fuels.		Briquets, test 127.
		Utah No. 1.	R. I. No. 1.	
Laboratory No	3410	3199	3141	
Air-drying loss.....per cent..		3.80	3.4	0.80
Extracted by CS_2:				
Air-dried.....do....		3.98	.02	6.95
As received.....do....	79.98	3.83	.02	6.89
Pitch in briquets as received.....do....				6.40

UTAH NO. 2.

Bituminous coal from Coalville, Summit County, on the Union Pacific Railroad, was designated Utah No. 2. The coal, as worked at a depth of 295 feet at this place, averages 10 feet in thickness.

The sample consisted of slack through a 1¼-inch screen and was shipped under the supervision of John W. Groves. It was used in steaming tests (on briquets) 402, 403, and 404, and briquetting test 132; also mixed with Rhode Island No. 1 in steaming test 416 (on briquets, see p. 224) and briquetting test 133.

Two mine samples were taken for chemical analysis. Sample 3200 was taken 5,000 feet east of the slope bottom on the 500-foot level, where the coal measured 10 feet 2 inches in thickness. Sample 3201 was taken 4,500 feet east of the slope on the 400-foot level, where the coal measured 10 feet 7 inches in thickness.

CHEMICAL ANALYSES.

Utah No. 2.

	Mine samples.		Car sample.	Steaming tests.[a]		
				402.	403.	404.
Laboratory No.	3200	3201	3259			
Air-drying loss	5.70	5.20	2.30			
Proximate:						
Moisture	14.07	13.86	12.66	11.53	9.32	10.02
Volatile matter	37.21	39.69	38.30	38.91	39.68	39.82
Fixed carbon	42.46	41.19	43.19	43.83	45.05	43.41
Ash	6.26	5.26	5.85	5.73	5.95	6.75
Sulphur	1.28	1.32	1.39	1.36	1.37	1.34
Ultimate:						
Hydrogen				4.70	4.75	4.63
Carbon				72.15	73.30	71.62
Nitrogen				1.27	1.27	1.29
Oxygen				13.86	12.61	13.47
Ash				6.48	6.56	7.50
Sulphur				1.54	1.51	1.49
Calorific value determined (as received) (calories	5,817					
received) (B. t. u.	10,471					

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Utah No. 2 (briquets.)

	Test 402.	Test 403.	Test 404.
Duration of test, hours	6.15	2.75	10.08
Heating value of fuel, B. t. u. per pound dry fuel	12,636	12,791	12,586
Force of draft:			
Under stack damper, inch water	0.65	0.43	0.55
Above fire, do	.18	.20	.22
Furnace temperature, °F	2,054	2,253	
Dry fuel used per square foot of grate surface per hour, pounds	24.83	16.28	17.19
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	2.87	2.58	2.47
Percentage of rated horsepower of boiler developed	80.4	72.4	69.2
Water apparently evaporated per pound of fuel as fired, pounds	4.43	6.19	5.64
Water evaporated from and at 212 °F.:			
Per pound of fuel as fired, do	5.12	7.21	6.48
Per pound of dry fuel, do	5.78	7.95	7.20
Per pound of combustible, do	7.23	9.22	8.56
Efficiency of boiler, including grate, per cent	44.18	60.02	55.24
Fuel as fired:			
Per indicated horsepower hour, pounds	5.52	3.92	4.36
Per electrical horsepower hour, do	6.82	4.84	5.39
Dry fuel:			
Per indicated horsepower hour, do	4.89	3.56	3.93
Per electrical horsepower hour, do	6.04	4.39	4.85

Remarks.—Test 402 on English briquets, from test 132 (see p. 266), which were broken in two before firing; they burned with some flame and held together well in the fire, with no smoke. Tests 403 and 404 on Renfrow briquets from test 132, which burned with a medium flame and very little smoke, and disintegrated badly in the fire. Very fine dark ash fell through the grate in large quantities, mixed with a good deal of green coal. No clinker formed with the English briquets, and very little with the Renfrow briquets.

BRIQUETTING TESTS.

Utah No. 2.

Test 132.—This coal, sent primarily for briquetting, had all the characteristics of lignite. Oil shale was sent to be used as a binder, but all efforts to use it for this purpose utterly failed. The English briquets with 5 and 6 per cent binder indicated a

shortage of pitch; outer surfaces rough, but crumbly and porous; crumbly at fracture, and broken and fractured surfaces were not firm. Briquets with 7 per cent binder showed improvement over the others, but were not satisfactory; outer surface harder, but could be roughened by rubbing; did not break clean; fractured surfaces not hard. In the drop test, with 6 per cent binder, the 1-inch screen held 54.4 per cent and passed 44.6 per cent. The Renfrow briquets with 6 per cent binder were soft and showed shortage of pitch. Those with 7 per cent binder showed improvement; broke with crumbly fracture and broken surfaces not firm. Eight per cent binder made good briquets, with hard outer surface; broke clean, and broken surfaces firm. For analyses of briquets see page 265 (steaming tests 402, 403, 404).

Test 133.—In this test Rhode Island No. 1, the only available high-volatile coal, was chosen in order to supplement the data of test 127 (p. 264). Test 133 was not successful, as coal showed characteristics of lignite, both in briquetting and burning. The mixture contained 47 per cent of each coal. Briquets with 6 per cent binder were tough and hard; outer surface smooth and very hard, the fracture rough, but clean and firm. No drop tests were made. For analyses of briquets see page 223 (steaming test 416).

	Test 132.		Test 133.
Size as used:			
Over ¼ inch ..... per cent..	0.8		1.2
1/10 inch to ¼ inch ..... do....	8.0		6.0
1/20 inch to 1/10 inch ..... do....	21.4		19.2
1/40 inch to 1/20 inch ..... do....	29.8		25.6
Under 1/40 inch ..... do....	40.0		48.0
Details of manufacture:			
Machine used	Eng.	Renf.	Renf.
Temperature of briquets ..... °F..	175	149	149
Binder:			
Kind	w.g.p.	w.g.p.	w.g.p.
Laboratory No. (see p. 40)	3,410	3,410	3,410
Amount ..... per cent..	6,7,8	5,6,7	6
Weight of—			
Fuel briquetted ..... pounds..	29,000	29,000	37,000
Briquets, average ..... do....	3.03	0.42	0.52
Heat value per pound—			
Fuel as received ..... B. t. u..	10,697	10,697	11,032
Fuel as fired ..... do....	11,180	11,180	11,527
Binder ..... do....	16,478	16,478	16,478
Weathering test:			
Time exposed ..... days....	190	190	190
Condition	D.	C.	E.

Extraction analyses.

	Pitch.	Fuel.		Briquets.	
		Utah No. 2.	R. I. No. 1.	Test 132.	Test 133.
Laboratory No	3410	3259	3141	.....	.....
Air-drying loss ..... per cent..	.....	2.30	3.40	1.60	1.40
Extracted by CS_2:					
Air-dried ..... do....	.....	.27	.02	4.69	6.15
As received ..... do....	79.98	.26	.02	4.61	6.06
Pitch in briquets as received ..... do....	.....	.....	.....	5.46	7.54

VIRGINIA.

VIRGINIA NO. 5.

Anthracite coal from the bed known as the "Big seam" (Brush Mountain field) 10 miles west of Blacksburg, Montgomery County, was designated Virginia No. 5. The coal, as worked from the outcrop at this place, averages 7 feet 8 inches in thickness.

Two samples were shipped under the supervision of R. T. Carroll, Virginia No. 5 A consisted of pea coal, and was used in steaming tests 476 and 482 and producer-gas test 154. Virginia No. 5 B consisted of 10 tons of slack coal, and was used in steaming test 494 (on briquets) and briquetting tests 187† and 188.

Two mine samples were taken for chemical analysis. Sample 4092 was taken 750 feet south of the opening, where the coal measured 7 feet 10 inches in thickness. Sample 4093 was taken 15 feet away, where the coal measured 7 feet 6 inches in thickness.

CHEMICAL ANALYSES.

Virginia No. 5.

	Mine samples.		Car samples.		Steaming tests.[a]			Briquetting test 187†.[b]
			A.	B.	A.		B.	
					476.	482.	494.	
Laboratory No.	4092	4093	4287	4294	.....	.....	4417	4545
Air-drying loss	3.10	2.40	4.10	7.10	.....	.....	.....	.....
Proximate:								
Moisture	3.51	2.98	4.80	7.52	4.73	4.60	5.02	4.52
Volatile matter	11.06	10.94	10.12	10.29	11.64	11.51	15.52	14.28
Fixed carbon	67.79	64.14	67.05	65.96	65.05	66.51	64.51	65.93
Ash	17.64	21.94	18.03	16.23	18.58	17.38	14.95	15.27
Sulphur	.84	.68	.63	.65	.67	.60	.84	.79
Ultimate:								
Hydrogen	.....	.....	3.91	4.37	3.53	3.58	3.66	3.68
Carbon	.....	.....	69.27	69.05	72.22	73.45	75.82	76.17
Nitrogen	.....	.....	.66	.69	.69	.70	.88	.81
Oxygen	.....	.....	7.50	9.01	3.36	3.42	3.02	2.51
Ash	.....	.....	.....	.....	19.50	18.22	15.74	16.00
Sulphur	.....	.....	.....	.....	.70	.63	.88	.83
Calorific value determined (as received)	calories	6,483	6,645	6,607	.....	.....	.....	.....
	B. t. u.	11,669	11,961	11,893	.....	.....	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Proximate analysis of fuel as received; ultimate analysis on dry basis.

STEAMING TESTS.

Virginia No. 5.

	A.		B.
	Test 476.	Test 482.	Test 494.[a]
Size as used:			
Over 1 inch, per cent	4.0	2.1	
½ inch to 1 inch, do	31.1	23.0	
¼ inch to ½ inch, do	37.7	36.4	See p. 268.
Under ¼ inch, do	2.72	38.5	
Average diameter, inch	0.53	0.45	
Duration of test, hours	9.40	6.53	7.00
Heating value of fuel, B. t. u. per pound dry fuel	12,472	12,679	13,122

[a] On briquets, equal weights from tests 187† and 188.

STEAMING TESTS—Continued.

Virginia No. 5.

	A.		B.
	Test 476.	Test 482.	Test 494.
Force of draft:			
Under stack damper....inch water..	0.83	0.63	0.84
Above fire....do....	.22	1.03	.20
In ash pit....do....	a .32	.08	.....
Dry fuel used per square foot of grate surface per hour....pounds..	22.74	35.31	20.07
Equivalent water evaporated per square foot of water-heating surface per hour....pounds..	3.56	5.27	3.58
Percentage of rated horsepower of boiler developed	99.7	147.7	100.4
Water apparently evaporated per pound of fuel as fired....pounds..	6.20	5.89	7.02
Water evaporated from and at 212° F.:			
Per pound of fuel as fired....do....	7.46	7.13	8.48
Per pound of dry fuel....do....	7.83	7.47	8.93
Per pound of combustible....do....	10.77	9.67	11.05
Efficiency of boiler, including grate....per cent..	60.63	56.90	65.72
Fuel as fired:			
Per indicated horsepower hour....pounds..	3.79	3.97	3.33
Per electrical horsepower hour....do....	4.68	4.90	4.12
Dry fuel:			
Per indicated horsepower hour....do....	3.61	3.79	3.17
Per electrical horsepower hour....do....	4.46	4.67	3.91

a During the last two hours.

PRODUCER-GAS TEST.

Virginia No. 5 A (pea).

Test 154.—Duration of test, 30 hours. Average electrical horsepower, 199.6. Average B. t. u. per cubic foot of gas, 160.7. Total coal fired, 7,950 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.37	1.33	1.08
Developed at switchboard	1.33	1.29	1.04
Per brake horsepower:			
Commercially available	1.17	1.13	.92
Developed at engine	1.13	1.09	.89
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.49	1.44	1.17
Developed at switchboard	1.44	1.39	1.13
Per brake horsepower:			
Commercially available	1.27	1.22	.99
Developed at engine	1.22	1.18	.96

Analyses.

Coal.		*Gas by volume.*	
Moisture	3.34	Carbon dioxide (CO_2)	10.2
Volatile matter	11.28	Carbon monoxide (CO)	19.1
Fixed carbon	67.24	Hydrogen (H_2)	20.5
Ash	18.14	Methane (CH_4)	1.9
Sulphur	.75	Nitrogen (N_2)	48.2
		Ethylene (C_2H_4)	.1

BRIQUETTING TESTS.

Virginia No. 5 B (slack).

Tests 187† and 188.—Size as used: Over $\frac{1}{4}$ inch, 0.6 per cent; $\frac{1}{10}$ inch to $\frac{1}{4}$ inch, 8.8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 23.6 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 27.6 per cent; through $\frac{1}{40}$ inch, 39.4 per cent. A very hard, nonporous briquet was made with 6 per cent

binder on the English machine. Renfrow briquets with 7 per cent binder stuck together in piling, showing excess of pitch; otherwise these briquets were satisfactory. This is an exceptionally good briquetting coal, requiring but a small percentage of binder and making briquets with firm, smooth outer surfaces, sharp edges, and characteristic glossy fracture. For analyses of briquets see page 267 (briquets from test 188 under steaming test 494).

	Test 187†.	Test 188.		Test 187†.	Test 188.
Details of manufacture:			Drop test (1-inch screen):		
Machine used	Renf.	Eng.	Held.....per cent..	78.5	85.7
Temperatures of briquets.....°F..	185	185	Passed.....do....	21.5	14.3
Binder—			Tumbler test (1-inch screen):		
Kind	w. g. p.	w. g. p.	Held.....per cent..	94.0	89.3
Laboratory No. (see p. 40)	4543	4543	Passed (fines).....do....	6.0	10.7
Amount...per cent..	7	6.25	Fines through 10-mesh sieve.....per cent..	96.9	79.1
Weight of—			Weathering test:		
Fuel briquetted, pounds	8,000	4,000	Time exposed.....days..	10	6
Briquets, average, pounds	0.457	4.11	Condition	A.	A.
Heat value per pound—			Water absorption:		
Fuel as received, B. t. u.	11,893	11,893	In 19 days.....per cent..	14.8	12.6
Fuel as fired..B. t. u..	12,542	12,463	Average for first 5 days, per cent	2.0	1.12
Binder.....do....	16,969	16,969	Specific gravity (apparent)..	1.182	1.209

Extraction analyses.

	Pitch.	Fuel.	Briquets.	
			Test 187†.	Test 188.
Laboratory No.	4543	4294	4545	4417
Air-drying loss.....per cent..	.....	7.10	3.60	4.10
Extracted by CS_2:				
Air-dried.....do....	.....	.29	6.47	5.99
As received.....do....	99.66	.27	6.24	5.74
Pitch in briquets as received.....do....	.....	.....	6.01	5.51

VIRGINIA NO. 6.

Bituminous coal from the bed locally known as No. 4, 5 miles northwest of Richlands, Tazewell County, on the Norfolk and Western Railway, was designated Virginia No. 6. The coal, as worked from the outcrop at this place, averages 5 feet ½ inch in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of run-of-mine coal and was used in steaming test 507, producer-gas test 160, washing test 198, and coking tests 181 (raw) and 184 (washed coal).

Two mine samples were taken for chemical analysis. Sample 4304 was taken 2,000 feet southeast of the opening, where the coal measured 5 feet 5 inches in thickness. Sample 4305 was taken 1,600 feet east of the opening, where the coal measured 4 feet 8 inches in thickness.

CHEMICAL ANALYSES.

Virginia No. 6.

	Mine samples.		Car sample.	Steaming test 507.[a]
Laboratory No.	4304	4305	4573	.....
Air-drying loss	2.40	1.90	5.00	.....
Proximate:				
Moisture	3.03	2.60	5.62	3.78
Volatile matter	25.82	24.47	23.07	23.08
Fixed carbon	66.53	68.45	61.52	63.85
Ash	4.62	4.48	9.79	9.29
Sulphur	1.70	1.35	1.21	1.16
Ultimate:				
Hydrogen	.....	.....	4.78	4.45
Carbon	.....	.....	73.35	78.41
Nitrogen	.....	.....	1.26	1.35
Oxygen	.....	.....	9.61	4.93
Ash	.....	.....	.....	9.65
Sulphur	.....	.....	.....	1.21
Calorific value determined (as received) calories	.....	8,131	7,369	.....
Calorific value determined (as received) B. t. u.	.....	14,636	13,264	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Virginia No. 6.

	Test 507.
Size as used:	
Over 1 inch ..... per cent.	13.5
½ inch to 1 inch ..... do	9.0
¼ inch to ½ inch ..... do	61.2
Under ¼ inch ..... do	.46
Average diameter ..... inch	8.87
Duration of test ..... hours	8.87
Heating value of coal ..... B. t. u. per pound dry coal	14,177
Force of draft:	
Under stack damper ..... inch water	.87
Above fire ..... do	.05
In ash pit ..... do	.24
Dry coal used per square foot of grate surface per hour ..... pounds	20.59
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	3.63
Percentage of rated horsepower of boiler developed	101.8
Water apparently evaporated per pound of coal as fired ..... pounds	7.01
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... do	8.49
Per pound of dry coal ..... do	8.83
Per pound of combustible ..... do	10.30
Efficiency of boiler, including grate ..... per cent	60.15
Coal as fired:	
Per indicated horsepower hour ..... pounds	3.33
Per electrical horsepower hour ..... do	4.11
Dry coal:	
Per indicated horsepower hour ..... do	3.20
Per electrical horsepower hour ..... do	3.95

PRODUCER-GAS TEST.

Virginia No. 6 (run of mine).

Test 160.—Duration of test, 50 hours. Average electrical horsepower, 193.1. Average B. t. u. per cubic foot of gas, 138.1. Total coal fired, 11,000 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.18	1.12	1.00
Developed at switchboard	1.14	1.09	.97
Per brake horsepower:			
Commercially available	1.00	.95	.85
Developed at engine	.97	.92	.83

PRODUCER-GAS TEST—Continued.

Virginia No. 6 (run of mine).

	Coal as fired.	Dry coal.	Combustible.
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.29	1.23	1.10
Developed at switchboard	1.25	1.19	1.07
Per brake horsepower:			
Commercially available	1.09	1.05	.93
Developed at engine	1.06	1.01	.91

Analyses.

Coal.		*Gas by volume.*	
Moisture	4.51	Carbon dioxide (CO_2)	10.5
Volatile matter	22.77	Carbon monoxide (CO)	17.4
Fixed carbon	62.64	Hydrogen (H_2)	14.3
Ash	10.08	Methane (CH_4)	2.0
Sulphur	1.59	Nitrogen (N_2)	55.5
		Ethylene (C_2H_4)	.3

WASHING TESTS.

Virginia No. 6.

Test 198.—Duration of test, 1¼ hours. Size as used, through 1-inch screen. Jig used, special; speed, 70 r. p. m.; stroke, 2½ inches. Raw coal, 8.31 tons; washed coal, 6.75 tons, 81 per cent; refuse, 1.56 tons, 19 per cent.

Analyses.

Sample tested.	Lab. No.	Moisture.	Ash.		Sulphur (per cent).
			Per cent.	Per cent reduction.	
Raw coal, car sample	4573	5.62	9.79	.....	1.21
Washed coal, test 198	4578	6.36	4.38	57	1.30
Refuse	.....	3.64	63.98	.....	6.15

Float and sink tests.

No. of test.	Size used (inch).	Specific gravity of solution used.	Percentage of float—		Sink (per cent).	Analyses.			
			To refuse.	To total sample.		Ash.		Sulphur.	
						Per cent.	Per cent reduction.	Per cent.	Per cent reduction.
On raw coal (preliminary):									
1	¾	1.35	.....	84	16	2.60	54	.95	21
2	¾	1.41	.....	85	15	2.98	48	.92	24
3	¾	1.45	.....	85	15	3.44	42	.95	21
4	¾	1.53	.....	87	13	3.53	41	.97	20
On refuse (float): [a]									
1	.....	1.35	15.30	2.90	.....	4.80	.....	1.39	.....
2	.....	1.41	15.75	2.99	.....	5.35	.....	1.78	.....
3	.....	1.45	15.90	3.02	.....	5.62	.....	1.75	.....
4	.....	1.51	19.25	3.65	.....	9.31	.....	2.79	.....

[a] Figures indicate that finer crushing is advantageous. It will be noted that in the washing test the sulphur shows a higher percentage in the washed coal than it did in the raw coal. This is caused by the reduction of the ash being so much greater than the reduction of the sulphur that the resulting percentage of the sulphur to the washed coal is higher than that of the original sulphur to the raw coal. By formula $Y=\frac{c-M}{c}$, it is found that 13 per cent of the sulphur in the raw coal was removed in washing.

Loss of "good coal" in the refuse will not exceed 2.2 per cent. By "good coal" is meant all coal of a quality equal to or better than that of the washed coal.

COKING TESTS.

Virginia No. 6 (run of mine).

		Test 181 (raw).	Test 184 (w.).
Size as used		f. c.	f. c.
Duration of test	hours.	50	48
Coal charged	pounds.	10,910	11,180
Coke produced	do.	6,698	6,150
	per cent.	61.39	55.01
Breeze produced	pounds.	267	191
	per cent.	2.45	1.72
Total yield	do.	63.84	56.71

Remarks.—Test 181: Light gray color; dense coke; breakage very irregular. Test 184: Light gray and silvery; good strong coke; washing reduced ash and sulphur.

Analyses.

	Test 181.		Test 184.	
	Coal.	Coke.	Coal.	Coke.
Moisture	5.05	0.38	5.48	0.24
Volatile matter	22.95	1.35	24.77	.32
Fixed carbon	62.11	86.05	64.96	93.73
Ash	9.89	12.22	4.79	5.71
Sulphur	1.49	1.44	1.45	1.24

WASHINGTON.

WASHINGTON NO. 1.

Subbituminous coal from Renton, King County, on the Seattle and Tacoma electric line, and also on a branch of the Great Northern Railway, was designated Washington No. 1. The coal is reached by a slope at this place.

These samples were shipped under the supervision of M. R. Campbell, as follows: Washington No. 1 A consisted of pea coal and was used in producer-gas test 90. Washington No. 1 B consisted of run-of-mine coal, and was used in steaming test 290 and producer-gas tests 89 and 94.

Two mine samples were taken for chemical analysis. Sample 2455 was taken 2,400 feet south of the slope and 4,300 feet from the mouth of the mine. Sample 2456 was obtained 150 feet from the slope and 2,300 feet from the mouth of the mine.

CHEMICAL ANALYSES.

Washington No. 1.

	Mine samples.		Car samples.		Steaming test 290.[a]
Laboratory No.	2455	2456	2687	2686	.....
Air-drying loss	9 90	12.90	10.70	9.60	.....
Proximate:					
Moisture	16.18	17.97	16.04	14.30	15.96
Volatile matter	35.65	35.13	31.39	33.03	34.53
Fixed carbon	39.31	39.12	41.04	41.30	37.43
Ash	8.86	7.78	11.53	11.37	12.08
Sulphur	.46	.43	.61	.72	.58

[a] Proximate analysis of fuel as fired.

CHEMICAL ANALYSES—Continued.

Washington No. 1.

	Mine samples.		Car samples.		Steaming test 290. [a]
Ultimate:					
Hydrogen			5.57	5.73	4.77
Carbon			56.51	57.27	66.09
Nitrogen			1.16	1.17	1.34
Oxygen			24.62	23.74	12.74
Ash					14.37
Sulphur					.69
Calorific value (as received):					
Determined, calories		5,559	5,521	5,671	
Determined, B. t. u.		10,006	9,938	10,208	
Calculated from ultimate analysis, calories			5,438	5,595	
Calculated from ultimate analysis, B. t. u.			9,788	10,071	

[a] Ultimate analysis of dry fuel figured from car sample.

STEAMING TEST.

Washington No. 1 B (run of mine).

	Test 290.
Size as used:	
Over 1 inch, per cent	38.9
½ inch to 1 inch, do	23.9
¼ inch to ½ inch, do	14.
Under ¼ inch, do	22.
Duration of test, hours	10.0
Heating value of coal, B. t. u. per pound dry coal	11,772
Force of draft:	
Under stack damper, inch water	0.59
Above fire, do	.12
Furnace temperature, °F.	2,047
Dry coal used per square foot of grate surface per hour, pounds	19.63
Equivalent water evaporated per square foot of water-heating surface per hour, do	2.92
Percentage of rated horsepower of boiler developed	81.8
Water apparently evaporated per pound of coal as fired, pounds	5.22
Water evaporated from and at 212° F.:	
Per pound of coal as fired, do	6.25
Per pound of dry coal, do	7.44
Per pound of combustible, do	9.26
Efficiency of boiler, including grate, per cent	61.03
Coal as fired:	
Per indicated horsepower hour, pounds	4.52
Per electrical horsepower hour, do	5.59
Dry coal:	
Per indicated horsepower hour, do	3.80
Per electrical horsepower hour, do	4.69

PRODUCER-GAS TESTS.

Washington No. 1.

	A.	B.	
	Test 90.	Test 89.	Test 94.
Size as shipped	Pea.	r. o. m.	r. o. m.
Size as used:			
Over 1 inch, per cent	9	45	68
½ inch to 1 inch, do	35	10	10
¼ inch to ½ inch, do	31	15	9
Under ¼ inch, do	25	30	13
Duration of test, hours	40	40	14
Average electrical horsepower	144.2	156.2	195.6
Average B. t. u. per cubic foot of gas	145.9	159.2	144.1
Total coal fired, pounds	18,900	16,450	6,550

PRODUCER-GAS TESTS—Continued.

Washington No. 1.

	Test 90 (A.)			Test 89 (B).			Test 94 (B).		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).									
Per electrical horsepower:									
Commercially available	3.53	2.96	2.51	2.83	2.37	1.99	2.52	2.12	1.77
Developed at switch board	3.28	2.75	2.34	2.63	2.21	1.86	2.39	2.01	1.68
Per brake horsepower:									
Commercially available	3.00	2.52	2.14	2.40	2.01	1.69	2.14	1.80	1.50
Developed at engine	2.79	2.34	1.99	2.24	1.88	1.58	2.03	1.71	1.43
Equivalent used by producer plant (pounds).									
Per electrical horsepower:									
Commercially available	3.71	3.11	2.64	3.03	2.54	2.14	2.73	2.29	1.91
Developed at switch board	3.44	2.89	2.45	2.82	2.37	1.99	2.59	2.17	1.81
Per brake horsepower:									
Commercially available	3.15	2.64	2.24	2.57	2.16	1.81	2.32	1.94	1.62
Developed at engine	2.93	2.45	2.08	2.40	2.01	1.69	2.20	1.85	1.54

Analyses.

	Test 90.	Test 89.	Test 94.		Test 90.	Test 89.	Test 94.
Coal.				*Gas by volume.*			
Moisture	16.17	16.21	16.02	Carbon dioxide (CO_2)	11.3	13.4	12.6
Volatile matter	34.00	34.07	33.27	Carbon monoxide (CO)	15.4	14.5	13.9
Fixed carbon	37.27	36.35	36.81	Hydrogen (H_2)	10.5	16.7	12.8
Ash	12.56	13.37	13.90	Methane (CH_4)	3.6	3.8	2.6
Sulphur	.53	.58	.59	Nitrogen (N_2)	59.2	51.6	57.4
				Oxygen (O_2)	.0	.0	.2
				Ethylene (C_2H_4)			.7

WASHINGTON NO. 2.

Bituminous coal from Roslyn, Kittitas County, on the Northern Pacific Railway, was designated Washington No. 2. The coal is worked at a depth of 625 feet at this place.

The sample, consisting of lump coal loaded under the supervision of M. R. Campbell, was used in steaming tests 359, 360, 361, and (on briquets) 412; producer-gas test 112; coking test 135; cupola tests 97 and 134; and briquetting test 125.

Two mine samples were taken for chemical analysis. Sample 2457 was taken about 6,000 feet from the mouth of the mine. Sample 2458 was taken about 2,000 feet from the foot of the shaft.

CHEMICAL ANALYSES.

Washington No. 2.

	Mine samples.		Car sample.	Steaming tests.[a]			
				359.	360.	361.	412.
Laboratory No	2458	2457	3098				
Air-drying loss	1.30	.90	1.30				
Proximate:							
Moisture	3.39	3.36	3.16	3.16	3.61	3.59	2.66
Volatile matter	37.34	36.15	36.49	36.49	35.63	35.97	37.39
Fixed carbon	48.88	46.58	48.09	48.09	48.95	48.85	48.89
Ash	10.39	13.91	12.26	12.26	11.81	11.59	11.06
Sulphur	.33	.36	.38	.38	.39	.37	.39
Ultimate:							
Hydrogen			5.15	4.96	4.98	4.99	4.86
Carbon			69.35	71.62	71.95	72.16	73.02
Nitrogen			1.24	1.28	1.29	1.29	1.48
Oxygen			11.62	9.09	9.12	9.15	8.88
Ash				12.66	12.25	12.03	11.36
Sulphur				.39	.41	.38	.40
Calorific value (as received):							
Determined—calories	7,137		6,992				
Determined—B. t. u.			12,586				
Calculated from ultimate analysis—calories			6,879				
Calculated from ultimate analysis—B. t. u.			12,382				

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Washington No. 2 (lump).

	Test 359.	Test 360.	Test 361.	Test 412.
Size as used:				
Over 1 inch, per cent	20.9	41.4	33.5	See p. 277
½ inch to 1 inch, do	21.3	22.3	22.8	
¼ inch to ½ inch, do	18.0	15.3	15.8	
Under ¼ inch, do	39.8	21.0	27.9	
Duration of test, hours	10.0	10.05	10.0	9.47
Heating value of fuel, B. t. u. per pound dry fuel	12,996	13,059	13,095	13,243
Force of draft:				
Under stack damper, inch water	0.60	0.67	0.68	0.63
Above fire, do	.13	.12	.12	.11
Furnace temperature, °F.	2,362	2,469	2,405	2,155
Dry fuel used per square foot of grate surface per hour, pounds	19.83	22.69	21.92	19.78
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.47	3.86	3.82	3.54
Percentage of rated horsepower of boiler developed	97.4	108.4	107.1	99.3
Water apparently evaporated per pound of fuel as fired, pounds	7.13	6.93	7.08	7.49
Water evaporated from and at 212 °F.:				
Per pound of fuel as fired, pounds	8.50	8.23	8.42	8.74
Per pound of dry fuel, do	8.78	8.54	8.73	8.98
Per pound of combustible, do	10.27	9.86	10.07	10.22
Efficiency of boiler, including grate, per cent	65.25	63.15	64.38	65.48
Fuel as fired:				
Per indicated horsepower hour, pounds	3.33	3.44	3.36	3.24
Per electrical horsepower hour, do	4.11	4.24	4.15	3.99
Dry fuel:				
Per indicated horsepower hour, do	3.22	3.31	3.24	3.15
Per electrical horsepower hour, do	3.98	4.09	4.00	3.89

Remarks.—Test 412 on briquets. English briquets burned very freely and cracked open to a depth of 2 inches, but coked and held together well. Renfrow briquets made a hotter fire than the others, probably owing to the fact that they were small and made a more compact fuel bed. The different percentages of pitch do not affect the burning qualities. No smoke. Refuse: Clinker was heavy and was brittle when hot, and slightly porous. Ash was heavy and of a reddish-brown color.

PRODUCER-GAS TEST.

Washington No. 2 (lump).

Test 112.—Duration of test, 35 hours. Average electrical horsepower 195.7. Average B. t. u. per cubic foot of gas, 168.6. Total coal fired, 9,300 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.44	1.38	1.18
Developed at switchboard	1.36	1.30	1.12
Per brake horsepower:			
Commercially available	1.22	1.17	1.00
Developed at engine	1.15	1.11	.95
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.52	1.46	1.25
Developed at switchboard	1.44	1.38	1.18
Per brake horsepower:			
Commercially available	1.29	1.24	1.06
Developed at engine	1.22	1.17	1.01

Analyses.

Coal.		Gas by volume.	
Moisture	4.01	Carbon dioxide (CO_2)	7.9
Volatile matter	34.61	Carbon monoxide(CO)	22.2
Fixed carbon	47.49	Hydrogen (H_2)	15.4
Ash	13.89	Methane (CH_4)	2.6
Sulphur	.38	Nitrogen (N_2)	51.5
		Ethylene (C_2H_4)	.4

COKING TEST.

Washington No. 2 (lump).

Test 135.—Size as used: Raw, finely crushed. Duration of test, 36 hours; coal charged, 10,000 pounds; coke produced, 5,477 pounds, 54.77 per cent; breeze produced, 444 pounds, 4.44 per cent. Total percentage yield, 59.21. Light gray, with deposit of carbon; fingered and brittle. Ash should be lowered and coke probably otherwise improved by washing.

Analyses.

	Coal.	Coke.
Moisture	3.07	1.02
Volatile matter	37.42	2.10
Fixed carbon	47.35	77.53
Ash	12.16	19.35
Sulphur	.44	.44

Cupola tests of coke made from Washington No. 2 coal.

CHARGE.

Cupola test No.	Coke.[a] Test No.	Specific gravity.	Ratio iron to coke.	Fluidity strip full.	Materials.	Divisions of charge. 1.	2.	3.	4.	5.	Total.
				Per ct.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
97	135	1.90	7	91.60	Coke	190	60	60	60	60	430
					Pig iron	570	420	420	420	420	2,250
					Scrap	190	140	140	140	140	750
134	135	1.90	7	97.22	Coke	200	58	58	57	57	430
					Pig iron	600	413	413	412	412	2,250
					Scrap	200	138	138	137	137	750

[a] Phosphorus in coke, 0.0847 per cent.

Cupola tests of coke made from Washington No. 2 coal—Continued.

RECORD OF MELT.

Cupola test No.	Blast pressure.		Iron running in—	Weight of iron.			Melting.				Recovered.	
	On at—	Maximum.		Poured.	Additional melted.	Total.	Time.	Rate per hour.	Ratio iron to coke	Loss.	Iron.	Coke.
		Oz.	*Min.*	*Lbs.*	*Lbs.*	*Lbs.*	*Min.*	*Lbs.*		*Per ct.*	*Lbs.*	*Lbs.*
97	9.41 a. m....	7	9	903	299	1,202	29	2,487	3.03	8.96	1,529	33
134	4.27 p. m...	7	7	1,411	365	1,776	30	3,552	4.46	3.40	1,112	32

LADLE RECORD.

Ladle No.	Test 97.		Test 134.		Ladle No.	Test 97.		Test 134.	
	Pounds.	Time (a.m.).	Pounds.	Time (p. m.).		Pounds.	Time (a. m.).	Pounds.	Time (p. m.)
1	24	9.53	78	4.43	12	51	10.13	73	4.55
2	36	9.56	30	4.43½	13	55	10.13½	68	4.55½
3	83	10.00	80	4.46	14	94	10.15	72	4.57
4	91	10.04	44	4.46½	15	30	10.18	68	4.57½
5	96	10.04½	78	4.48	16	9	10.19	107	4.58
6	17	10.05	41	4.48½	17			79	4.59
7	58	10.08	73	4.49	18			21	5.00
8	76	10.09	98	4.50	19			56	5.01½
9	64	10.10	26	4.50½	20			59	5.02
10	59	10.10½	88	4.51½	21			88	5.04
11	60	10.12	84	4.53					

Remarks.—Test 97: Iron cold.

BRIQUETTING TEST.

Washington No. 2 (lump).

Test 125.—Size as used: Over ¼ inch, 2.4 per cent; $\frac{1}{10}$ inch to ¼ inch, 11 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 19.6 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 26.2 per cent; through $\frac{1}{40}$ inch, 40.8 per cent. Kind of binder, water-gas pitch; laboratory No. 3410 (see p. 40). Weight of fuel briquetted, 12,000 pounds. B. t. u. per pound of coal as received 12,586; per pound of briquets as fired, 12,890; per pound of binder, 16,478.

English briquets, average weight 3.24 pounds, proved that 5.5 per cent binder was insufficient, as shown by general lack of cohesion at edges and surfaces of whole briquets and of fracture. With 6 per cent binder, briquets were still crumbly, but better than those with 5.5 per cent. With 6.5 and 7 per cent binder, briquets were cohesive, with firm edges and surfaces hard and smooth. In the drop test with 6 per cent binder the 1-inch screen held 87.4 per cent and passed 12.6 per cent. In the weathering test all briquets were exposed 214 days; condition of those with 5.5 per cent binder C, of the others B.

Renfrow briquets, average weight 0.46 pound, in weathering test were exposed 214 days; condition of those with 6.5 per cent binder, C; of those with 7 and 7.5 per cent binder, B.

For analyses of briquets see page 275 (steaming test 412).

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 125.
Laboratory No	3410	3098	.....
Air-drying loss, per cent	.....	1.30	0.20
Extracted by CS_2:			
Air dried, do	.....	1.26	6.90
As received, do	79.98	1.24	6.89
Pitch in briquets as received, do	.....	.....	7.19

WEST VIRGINIA.

WEST VIRGINIA NO. 11.[a]

A car of bone coal from Pocahontas bed No. 3 at Zenith (Crumpler station), Monroe County, on the Norfolk and Western Railway, was designated West Virginia No. 11 B. This sample was shipped under the supervision of John W. Groves and used in producer-gas test 161.

This carload was picked up by hand beside the tipple, where it had accumulated in ridges along the tracks by being thrown away while cleaning and loading cars. The process of picking up the lumps by hand naturally eliminated the fine coal that was broken off the lumps, making a smaller per cent of good coal than would be the case in loading from a bin.

No mine samples were taken at the time of shipment. One sample of representative bone coal was carefully cleaned of all good coal adhering to it and sent in for chemical analysis.

CHEMICAL ANALYSIS.

West Virginia No. 11 B (bone coal).

Laboratory No	42.31
Air-drying loss	.60
Moisture	1.02
Volatile matter	9.08
Fixed carbon	44.47
Ash	45.43
Sulphur	.30

PRODUCER-GAS TEST.

West Virginia No. 11 B (bone coal).

Test 161.—Duration of test, 50 hours. Average electrical horsepower, 194.3. Average B. t. u. per cubic foot of gas, 144.0. Total coal fired, 18,900 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.00	1.99	1.12
Developed at switchboard	1.95	1.94	1.09
Per brake horsepower:			
Commercially available	1.70	1.69	.95
Developed at engine	1.65	1.64	.92

Analyses.

Coal.		*Gas by volume.*	
Moisture	0.47	Carbon dioxide (CO_2)	9.7
Volatile matter	8.83	Carbon monoxide (CO)	19.5
Fixed carbon	46.96	Hydrogen (H_2)	16.6
Ash	43.74	Methane (CH_4)	1.6
Sulphur	.27	Nitrogen (N_2)	52.6

[a] For other tests of coal from this mine, made during 1904, see Bull. U. S. Geol. Survey No. 261, 1905, pp. 58, 83, 129; Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 133, 259, 905, 1365.

WEST VIRGINIA NO. 16.[a]

Bituminous lump coal from Monongah, Marion County, on the Baltimore and Ohio Railroad, was designated West Virginia No. 16 A. Coal over a ¾-inch screen, loaded under the supervision of J. S. Burrows, was used in steaming tests 304 and 305.

CHEMICAL ANALYSES.

West Virginia No. 16 A.

	Steaming tests.[a]			Steaming tests.[a]	
	304.	305.		304.	305.
Proximate:			Ultimate:		
Moisture	4.12	6.79	Hydrogen	4.99	4.98
Volatile matter	33.83	31.71	Carbon	77.43	77.38
Fixed carbon	54.05	53.61	Nitrogen	1.58	1.57
Ash	8.00	7.89	Oxygen	6.44	6.44
Sulphur	1.17	1.09	Ash	8.34	8.46
			Sulphur	1.22	1.17

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

West Virginia No. 16 A (lump).

	Test 304.	Test 305.
Size as used:		
Over 1 inch ..... per cent..	50.6	33.9
½ inch to 1 inch ..... do....	22.8	19.6
¼ inch to ½ inch ..... do....	10.1	19.0
Under ¼ inch ..... do....	16.5	27.5
Duration of test ..... hours..	5.3	5.33
Kind of grate	Rocking.	
Heating value of coal ..... B. t. u. per pound dry coal..	13,896	13,964
Force of draft:		
Under stack damper ..... inch water..	0.42	0.49
Above fire ..... do....	.14	.09
Furnace temperature ..... ° F..	2,864	2,548
Dry coal used per square foot of grate surface per hour ..... pounds..	20.88	16.37
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.85	3.33
Percentage of rated horsepower of boiler developed	108.0	93.4
Water apparently evaporated per pound of coal as fired ..... pounds..	8.18	7.89
Water evaporated from and at 212° F.:		
Per pound of coal as fired ..... do....	9.88	9.50
Per pound of dry coal ..... do....	10.30	10.20
Per pound of combustible ..... do....	11.56	11.29
Efficiency of boiler, including grate ..... per cent..	71.58	70.54
Coal as fired:		
Per indicated horsepower hour ..... pounds..	2.86	2.98
Per electrical horsepower hour ..... do....	3.53	3.68
Dry coal:		
Per indicated horsepower hour ..... do....	2.74	2.77
Per electrical horsepower hour ..... do....	3.39	3.42

WEST VIRGINIA NO. 22.

Bituminous coal from a bed at Hernshaw, Kanawha County, on the Chesapeake and Ohio Railway, was designated "West Virginia No. 22." This coal has not been definitely correlated with any of the well-known coals of the region. As mined at the outcrop, it is 5 feet 9¾ inches in average thickness.

Two samples were shipped under the supervision of John W. Groves. West Virginia No. 22 A consisted of screenings through a

[a] For other tests of this coal, made during 1905, see Bull. U. S. Geol. Survey No. 290, 1906, p. 209.

1¼-inch screen, and was used in steaming tests 446, 447, and (washed coal) 454, and in washing test 186. West Virginia No. 22 B consisted of run-of-mine coal, and was used in steaming test 438.

Two mine samples were taken for chemical analysis. Sample 3456 was taken 400 feet east of the opening, where the coal measured 6 feet 6½ inches in thickness. Sample 3457 was taken 1,200 feet east of the opening, where the coal measured 4 feet 3 inches in thickness.

CHEMICAL ANALYSES.

West Virginia No. 22.

	Mine samples.		Car sample.	Steaming tests.[a]			
				A.			B.
				446.	447.	454.	438.
Laboratory No.	3456	3457	3905				
Air-drying loss	0.90	1.50	2.00				
Proximate:							
Moisture	2.75	3.49	3.42	5.44	5.55	5.24	3.42
Volatile matter	35.49	33.67	33.49	29.31	29.65	33.67	33.49
Fixed carbon	56.27	56.40	55.27	51.64	51.33	54.99	55.27
Ash	5.49	6.44	7.82	13.61	13.47	6.10	7.82
Sulphur	.63	.63	.83	.95	1.04	.90	.83
Ultimate:							
Hydrogen			5.27	4.72	4.72	5.17	4.96
Carbon			74.49	72.02	72.03	78.82	77.13
Nitrogen			1.20	1.15	1.15	1.26	1.24
Oxygen			10.39	6.72	6.74	7.36	7.71
Ash				14.39	14.26	6.44	8.10
Sulphur				1.00	1.10	.95	.86
Calorific value determined (as received)	7,674 calories.	7,674 calories.	7,492 calories.				
	13,813 B. t. u.	13,813 B. t. u.	13,486 B. t. u.				

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

West Virginia No. 22.

	A.			B.
	Test 446.	Test 447.	Test 454 (w.).	Test 438.
Size as used:				
Over 1 inch, per cent	9.7	5.6	15.2	53.6
½ inch to 1 inch, do	17.8	15.8	26.8	20.0
¼ inch to ½ inch, do	21.5	20.8	21.7	10.0
Under ¼ inch, do	51.0	57.8	36.3	16.4
Average diameter, inches	0.48	0.41	0.61	1.27
Duration of test, hours	10.22	9.68		9.55
Heating value of coal, B. t. u. per pound dry coal	12,838	12,843	14,152	13,963
Force of draft:				
Under stack damper, inch water	0.81	0.81	0.75	0.79
Above fire, do	.17	.19	.16	.09
Furnace temperature, °F.	2,616	2,801	2,793	
Dry coal used per square foot of grate surface per hour, pounds	18.94	20.22	20.99	21.97
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.08	3.54	3.93	4.20
Percentage of rated horsepower of boiler developed	86.4	99.1	110.3	117.6
Water apparently evaporated per pound of coal as fired, pounds	6.58	7.06	7.42	7.89
Water evaporated from and at 212° F.:				
Per pound of coal as fired, pounds	7.71	8.28	8.90	9.24
Per pound of dry coal, do	8.16	8.76	9.39	9.57
Per pound of combustible, do	10.00	10.61	10.33	10.60
Efficiency of boiler, including grate, per cent	61.38	65.87	64.08	66.19
Coal as fired:				
Per indicated horsepower hour, pounds	3.67	3.42	3.18	3.06
Per electrical horsepower hour, do	4.53	4.22	3.92	3.78
Dry coal:				
Per indicated horsepower hour, do	3.47	3.23	3.01	2.96
Per electrical horsepower hour, do	4.28	3.99	3.72	3.65

WASHING TEST.

West Virginia No. 22 A (nut and slack).

Test 186.—Jig used, Stewart. Raw coal, 38,250 pounds. Washed coal, 32,250 pounds; 84 per cent. Refuse, 6,000 pounds; 16 per cent.

Analyses.

	Raw coal.	Washed coal.
Moisture	4.59	7.06
Volatile matter	33.38	33.34
Fixed carbon	52.23	53.84
Ash	9.80	5.76
Sulphur	1.01	.97

WEST VIRGINIA NO. 23.

Bituminous coal from the Cedar Grove bed, one-fourth mile northeast of Monarch, Kanawha County, on the Kanawha and Michigan Railroad, was designated West Virginia No. 23. The coal, as worked from the outcrop at this place, averages 3 feet 1½ inches in thickness.

Two samples were shipped under the supervision of John W. Groves. West Virginia No. 23 A consisted of run-of-mine coal and was used in steaming tests 439 and 440. West Virginia No. 23 B consisted of slack through a 1½-inch screen, and was used in steaming tests 444 (washed) and 445 and washing test 180.

Two mine samples were taken for chemical analysis. Sample 3458 was taken 1,500 feet north of the opening, where the coal measured 3 feet 1¼-inches in thickness. Sample 3459 was taken 1,500 feet northwest of the opening, where the coal measured 3 feet 2 inches in thickness.

CHEMICAL ANALYSES.

West Virginia No. 23.

	Mine samples.		Car samples.		Steaming tests.[a]			
			A.	B.	A.		B.	
					439.	440.	444.	445.
Laboratory No.	3458	3459	3965	3625				
Air-drying loss	1.40	2.50	.60	1.70				
Proximate:								
Moisture	3.13	4.17	2.05	3.25	2.05	2.61	4.06	2.44
Volatile matter	35.51	35.36	34.71	34.61	34.71	34.15	35.70	33.30
Fixed carbon	57.82	54.17	55.14	54.56	55.14	53.96	55.44	53.67
Ash	3.54	6.30	8.10	7.58	8.10	9.28	4.80	10.59
Sulphur	.59	1.24	1.35	1.22	1.35	1.52	.95	1.40
Ultimate:								
Hydrogen			5.08	5.23	4.95	4.88	5.20	4.86
Carbon			75.56	75.27	77.14	75.91	80.44	75.06
Nitrogen			1.18	1.43	1.21	1.18	1.53	1.42
Oxygen			8.73	9.27	7.05	6.94	6.84	6.38
Ash					8.27	9.53	5.00	10.85
Sulphur					1.38	1.56	.99	1.43
Calorific value determined (as received) calories	7,757		7,615	7,513				
B. t. u.	13,963		13,707	13,523				

[a] Proximate analysis of fuel as fired: ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

West Virginia No. 23.

	A.		B.	
	Test 439.	Test 440.	Test 444 (w.).	Test 445.
Size as used:				
Over 1 inch....per cent..	56.3	32.9	12.1	25.2
½ inch to 1 inch....do....	21.9	20.0	23.2	21.6
¼ inch to ½ inch....do....	12.0	15.4	24.6	16.6
Under ¼ inch....do....	9.8	31.7	40.1	36.6
Average diameter....inches..	1.31	.87	.56	.70
Duration of test....hours..	9.95	9.83	10.05	10.00
Heating value of coal....B. t. u. per pound dry coal..	13,995	13,781	14,483	13,498
Force of draft:				
Under stack damper....inch water..	0.77	0.75	0.78	0.77
Above fire....do....	.12	.12	.10	.13
Furnace temperature....° F..	2,657	2,572	2,536	2,638
Dry coal used per square foot of grate surface per hour, pounds	19.98	18.82	17.51	19.11
Equivalent water evaporated per square foot of water-heating surface per hour....pounds..	3.56	3.41	3.14	3.42
Percentage of rated horsepower of boiler developed....	99.7	95.6	88.0	95.9
Water apparently evaporated per pound of coal as fired, pounds....	7.49	7.63	7.37	7.47
Water evaporated from and at 212° F.:				
Per pound of coal as fired....pounds..	8.73	8.84	8.61	8.75
Per pound of dry coal....do....	8.92	9.08	8.98	8.97
Per pound of combustible....do....	10.20	10.49	9.92	10.65
Efficiency of boiler, including grate....per cent..	61.55	63.62	59.88	64.17
Coal as fired:				
Per indicated horsepower hour....pounds..	3.24	3.20	3.28	3.23
Per electrical horsepower hour....do....	4.00	3.95	4.05	3.99
Dry coal:				
Per indicated horsepower hour....do....	3.17	3.11	3.15	3.15
Per electrical horsepower hour....do....	3.91	3.84	3.89	3.89

WASHING TEST.

West Virginia No. 23 B (nut and slack).

Test 180.—Jig used, Stewart. Raw coal, 36,000 pounds. Washed coal, 33,980 pounds; 94 per cent. Refuse, 2,020 pounds; 6 per cent. Analyses: For analyses of the fuel used see page 281 (sample 3625). Analysis of the washed coal: Moisture, 4.24; ash, 4.87; sulphur, 0.93.

WEST VIRGINIA NO. 24.

A sample of bone coal from the Pocahontas bed No. 3 at Gary, McDowell County, on the Norfolk and Western Railway, was designated West Virginia No. 24. This sample was shipped under the supervision of A. K. Adams and was used in producer-gas test 162.

PRODUCER-GAS TEST.

West Virginia No. 24 (bone coal).

Test 162.—Duration of test, 50 hours. Average electrical horsepower, 148.8. Average B. t. u. per cubic foot of gas, 106.3. Total coal fired, 11,000 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.55	1.51	1.07
Developed at switchboard	1.48	1.44	1.02
Per brake horsepower:			
Commercially available	1.32	1.28	.91
Developed at engine	1.26	1.22	.87

Analyses.

Coal.		*Gas by volume.*	
Moisture	2.91	Carbon dioxide (CO_2)	12.4
Volatile matter	11.81	Carbon monoxide (CO)	14.0
Fixed carbon	57.19	Hydrogen (H_2)	13.8
Ash	28.08	Methane (CH_4)	1.2
Sulphur	.54	Nitrogen (N_2)	58.6

WEST VIRGINIA NO. 25.

Bituminous coal from the Black Band bed, 8 miles southeast of Charleston, Kanawha County, on the Chesapeake and Ohio Railway, was designated West Virginia No. 25. The coal, as worked from the outcrop at this place, averages 2 feet 9¾ inches in thickness.

One sample, shipped under the supervision of John W. Groves, consisted of lump coal over a 1¼-inch screen, and was used in producer-gas test 156 and coking test 175.

Two mine samples were taken for chemical analysis. Sample 4290 was taken 1,300 feet south of the opening, where the coal measured 2 feet 8¾ inches in thickness. Sample 4291 was taken 800 feet west of the opening, where the coal measured 2 feet 11 inches in thickness.

CHEMICAL ANALYSES.

West Virginia No. 25.

	Mine samples.		Car sample.		Mine samples.		Car sample.
Laboratory No.	4290	4291	4360	Ultimate:			
Air-drying loss	1.80	2.10	2.30	Hydrogen			5.16
Proximate:				Carbon			72.89
Moisture	3.46	3.91	4.21	Nitrogen			1.40
Volatile matter	34.55	34.83	35.41	Oxygen			12.69
Fixed carbon	53.79	54.48	53.16	Calorific value determined (as received). calories		7,484	7,433
Ash	8.20	6.78	7.22	Calorific value determined (as received). B. t. u.		13,471	13,379
Sulphur	.58	.64	.64				

PRODUCER-GAS TEST.

West Virginia No. 25 (lump).

Test 156.—Duration of test, 50 hours. Average electrical horsepower, 199.2. Average B. t. u. per cubic foot of gas, 171.6. Total coal fired, 13,000 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.35	1.30	1.19
Developed at switchboard	1.31	1.26	1.15
Per brake horsepower:			
Commercially available	1.15	1.11	1.01
Developed at engine	1.11	1.07	.98
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	1.42	1.37	1.25
Developed at switchboard	1.37	1.32	1.21
Per brake horsepower:			
Commercially available	1.21	1.16	1.06
Developed at engine	1.17	1.12	1.03

Analyses.

Coal.		*Gas by volume.*	
Moisture	3.83	Carbon dioxide (CO_2)	7.9
Volatile matter	34.34	Carbon monoxide (CO)	23.4
Fixed carbon	53.61	Hydrogen (H_2)	17.1
Ash	8.22	Methane (CH_4)	2.1
Sulphur	.62	Nitrogen (N_2)	49.1
		Ethylene (C_2H_4)	.4

COKING TEST.

West Virginia No. 25 (lump).

Test 175.—Size as used: Raw, finely crushed. Duration of test, 43 hours. Coal charged, 11,340 pounds. Coke produced, 6,920 pounds, 61.02 per cent. Breeze produced, 381 pounds, 3.36 per cent. Total yield, 64.38 per cent. Good strong coke; gray color with a little silvery deposit of carbon.

Analyses.

	Coal.	Coke.
Moisture	4.56	0.30
Volatile matter	34.38	.49
Fixed carbon	53.39	86.71
Ash	7.67	12.50
Sulphur	.61	.47

WYOMING.

WYOMING NO. 4.

Bituminous coal from Hanna, Carbon County, on the Union Pacific Railroad, was designated Wyoming No. 4. The coal, as worked at a depth of 387 feet at this place, averages 35 feet in thickness.

This sample, consisting of run-of-mine coal shipped under the supervision of John W. Groves, was used in steaming test 399 and producer-gas test 123.

Four mine samples were taken for analysis. Sample 3160 was taken 1,900 feet south of the slope. Sample 3161 was taken 2,000 feet south of the slope. Sample 3162 was taken 1,700 feet south of the slope. Sample 3163 was taken immediately above the point where sample 3162 was taken. The two benches combined measured 35 feet.

CHEMICAL ANALYSES.

Wyoming No. 4.

	Mine samples.				Car samples.		Steaming test 399.[a]
Laboratory No.	3160	3161	3162	3163	[b] 3363	[c] 3396	.....
Air-drying loss	3.80	4.10	4.00	3.50	2.30	3.80	.....
Proximate:							
Moisture	12.32	12.66	11.49	11.73	11.30	12.40	12.40
Volatile matter	40.80	40.36	40.38	41.30	40.32	39.75	39.75
Fixed carbon	41.69	43.10	42.24	41.40	41.07	41.08	41.08
Ash	5.19	3.88	5.89	5.57	7.31	6.77	6.77
Sulphur	.23	.21	.44	.29	.28	.26	.26

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.
[b] Sample from producer-gas test 123 treated as car sample.
[c] Sample from steaming test 399 treated as car sample.

CHEMICAL ANALYSES—Continued.

Wyoming No. 4.

	Mine samples.				Car samples.		Steaming test 399.
Ultimate:							
Hydrogen					5.56	6.37	5.70
Carbon					61.24	61.58	70.30
Nitrogen					.88	.85	.97
Oxygen					24.73	24.17	15.00
Ash							7.73
Sulphur							.30
Calorific value (as received):							
Determined—calories	6,168				5,975	5,948	
Determined—B. t. u.	11,102				10,755	10,706	
Calculated from ultimate analysis—calories					5,806	6,136	
Calculated from ultimate analysis—B. t. u.					10,451	11,045	

STEAMING TEST.

Wyoming No. 4 (run of mine).

	Test 399.
Size as used:	
Over 1 inch, per cent	23.1
½ inch to 1 inch, do	18.3
¼ inch to ½ inch, do	19.2
Under ¼ inch, do	39.4
Duration of test, hours	10.02
Heating value of coal, B. t. u. per pound dry coal	12,222
Force of draft:	
Under stack damper, inch water	0.60
Above fire, do	.38
Furnace temperature, °F.	26.26
Dry coal used per square foot of grate surface per hour, pounds	23.97
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.40
Percentage of rated horsepower of boiler developed	95.2
Water apparently evaporated per pound of coal as fired, pounds	5.32
Water evaporated from and at 212° F.:	
Per pound of coal as fired, do	6.22
Per pound of dry coal, do	7.10
Per pound of combustible, do	8.18
Efficiency of boiler, including grate, per cent	56.10
Coal as fired:	
Per indicated horsepower hour, pounds	4.55
Per electrical horsepower hour, do	5.62
Dry coal:	
Per indicated horsepower hour, do	3.98
Per electrical horsepower hour, do	4.92

PRODUCER-GAS TEST.

Wyoming No. 4 (run of mine).

Test 123.—Duration of test, 50 hours. Average electrical horsepower, 195.5. Average B. t. u. per cubic foot of gas, 151.6. Total coal fired, 20,200 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.20	1.95	1.79
Developed at switchboard	2.07	1.83	1.68
Per brake horsepower:			
Commercially available	1.87	1.66	1.52
Developed at engine	1.76	1.56	1.43
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.38	2.11	1.94
Developed at switchboard	2.24	1.99	1.83
Per brake horsepower:			
Commercially available	2.02	1.80	1.65
Developed at engine	1.91	1.69	1.55

Analysis of gas by volume.[a]

Carbon dioxide (CO_2)	12.2
Carbon monoxide (CC)	16.4
Hydrogen (H_2)	15.1
Methane (CH_4)	2.7
Nitrogen (N_2)	53.2
Ethylene (O_2H_4)	.4

WYOMING NO. 5.

Bituminous coal from Rock Springs, Sweetwater County, on the Union Pacific Railroad, was designated Wyoming No. 5. The coal, as worked at a depth of 493 feet at this place, averages 7 feet 6 inches in thickness.

The sample, consisting of run-of-mine coal, shipped under the inspection of John W. Groves, was used in producer-gas test 114 and coking test 132.

Two mine samples were taken for chemical analysis. Sample 3164 was taken 5,200 feet north of the slope, where the coal measured 7 feet 6 inches in thickness. Sample 3165 was taken 7,000 feet north of the slope, where the coal measured 7 feet 2 inches in thickness.

CHEMICAL ANALYSES.

Wyoming No. 5.

	Mine samples.		Car sample.
Laboratory No.	3164	3165	3213
Air-drying loss	4.00	4.40	6.00
Proximate:			
Moisture	12.41	13.10	11.64
Volatile matter	36.57	34.97	36.37
Fixed carbon	48.50	48.59	48.58
Ash	2.52	3.34	3.41
Sulphur	.80	1.04	.81
Ultimate:			
Hydrogen	.....	.....	5.72
Carbon	.....	.....	66.08
Nitrogen	.....	.....	1.43
Oxygen	.....	.....	22.55
Calorific value (as received):			
Determined, calories	6,622	.....	6,538
Determined, B. t. u.	11,920	.....	11,768
Calculated from ultimate analysis, calories	.....	.....	6,357
Calculated from ultimate analysis, B. t. u.	.....	.....	11,443

PRODUCER-GAS TEST.

Wyoming No. 5 (run of mine).

Test 114.—Duration of test, 50 hours. Average electrical horsepower, 194.5. Average B. t. u. per cubic foot of gas, 168. Total coal fired, 15,600 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.72	1.52	1.46
Developed at switchboard	1.60	1.42	1.36
Per brake horsepower:			
Commercially available	1.46	1.29	1.24
Developed at engine	1.36	1.21	1.16

[a] For analysis of fuel used see p. 284 (sample 3363).

Analyses.

Coal.		*Gas by volume.*	
Moisture	11.44	Carbon dioxide (CO_2)	10.1
Volatile matter	36.37	Carbon monoxide (CO)	20.4
Fixed carbon	48.49	Hydrogen (H_2)	18.2
Ash	3.70	Methane (CH_4)	2.6
Sulphur	.91	Nitrogen (N_2)	48.3
		Ethylene (C_2H_4)	.4

COKING TEST.

Wyoming No. 5 (run of mine).

Test 132.—Size as used: Raw, finely crushed. Duration of test, 39 hours. Coal charged, 8,000 pounds. Coke produced, none. Analysis of coal: Moisture, 11.09; volatile matter, 34.53; fixed carbon, 50.5; ash, 3.88; sulphur, 0.84.

WYOMING NO. 6.

Subbituminous coal 3 miles west of Kemmerer, Uinta County, 2 miles from the Union Pacific Railroad, was designated Wyoming No. 6.

This sample, consisting of run-of-mine coal, loaded under the supervision of John W. Groves, was used in steaming tests 400 and (on briquets) 419, producer-gas test 124, and briquetting test 134.

Two mine samples were taken for chemical analysis. Sample 3202 was taken 150 feet north of the opening. Sample 3203 was taken 180 feet north of the drift opening. These two samples combined represent a thickness of 23 feet. The total thickness of the bed worked in this mine is 83 feet; consequently these two samples represent only a part of the entire bed.

CHEMICAL ANALYSES.

Wyoming No. 6.

	Mine samples.		Car sample.	Steaming tests.[a]	
				400.	419.
Laboratory No	3202	3203	3390	.....	.....
Air-drying loss	10.20	10.60	11.30	.....	.....
Proximate:					
Moisture	20.57	20.88	19.00	18.44	15.57
Volatile matter	36.31	35.91	36.64	36.35	38.74
Fixed carbon	40.49	40.65	41.24	40.68	42.87
Ash	2.63	2.56	3.12	4.53	2.82
Sulphur	.51	.54	.49	.57	.59
Ultimate:					
Hydrogen	.....	.....	6.41	5.21	4.99
Carbon	.....	.....	59.38	71.93	74.59
Nitrogen	.....	.....	.98	1.19	1.03
Oxygen	.....	.....	29.62	15.42	15.35
Ash	.....	.....	.....	5.55	3.34
Sulphur	.....	.....	.....	.70	.70
Calorific value (as received):					
Determined, calories	5,687	.....	5,726	.....	.....
Determined, B. t. u.	10,237	.....	10,307	.....	.....
Calculated from ultimate analysis, calories	.....	.....	5,743	.....	.....
Calculated from ultimate analysis, B. t. u.	.....	.....	10,337	.....	.....

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Wyoming No. 6 (run of mine.)

	Test 400.	Test 419.
Size as used:		
Over 1 inch, per cent	13.3	See p. 289
½ inch to 1 inch, do	25.5	
¼ to ½ inch, do	25.4	
Under ¼ inch, do	35.8	
Duration of test, hours	10.02	9.45
Heating value of fuel, B. t. u. per pound dry fuel	12,488	13,021
Force of draft:		
Under stack damper, inch water	0.62	0.56
Above fire, do	.33	.24
Furnace temperature, °F.	2,465	.....
Dry fuel used per square foot of grate surface per hour, pounds	24.41	14.06
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.32	1.99
Percentage of rated horsepower of boiler developed	93.1	55.7
Water apparently evaporated per pound of fuel as fired, pounds	4.76	5.13
Water evaporated from and at 212° F.:		
Per pound of fuel as fired, do	5.56	5.97
Per pound of dry fuel, do	6.82	7.07
Per pound of combustible, do	7.92	8.44
Efficiency of boiler, including grate, per cent	52.74	52.43
Fuel as fired:		
Per indicated horsepower hour, pounds	5.08	4.74
Per electrical horsepower hour, do	6.28	5.85
Dry fuel:		
Per indicated horsepower hour, do	4.15	4.00
Per electrical horsepower hour, do	5.12	4.94

Remarks.—Test 419 on briquets, which in burning gave a shower of sparks instead of a flame. For the first five hours too thick a fire was carried. With a 5-inch fire during the second five hours the briquets burned far better. No smoke. Briquets held together for about seven minutes, burning very slowly, and then crumbled. No clinker; ash fell through grate freely.

PRODUCER-GAS TEST.

Wyoming No. 6 (run of mine).

Test 124.—Duration of test, 50 hours. Average electrical horsepower, 200. Average B. t. u. per cubic foot of gas, 171.8. Total coal fired, 21,900 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	2.32	1.90	1.83
Developed at switchboard	2.19	1.79	1.73
Per brake horsepower:			
Commercially available	1.97	1.61	1.56
Developed at engine	1.86	1.52	1.47
Equivalent used by producer plant (pounds).			
Per electrical horsepower:			
Commercially available	2.52	2.06	1.99
Developed at switchboard	2.38	1.94	1.88
Per brake horsepower:			
Commercially available	2.14	1.75	1.69
Developed at engine	2.02	1.65	1.59

Analyses.

Coal.		*Gas by volume.*	
Moisture	18.26	Carbon dioxide (CO_2)	12.1
Volatile matter	37.18	Carbon monoxide (CO)	18.7
Fixed carbon	41.82	Hydrogen (H_2)	19.3
Ash	2.74	Methane (CH_4)	3.0
Sulphur	.47	Nitrogen (N_2)	46.5
		Ethylene (C_2H_4)	.4

BRIQUETTING TEST.

Wyoming No. 6 (run of mine).

Test 134.—Size as used: Over ¼ inch, 2.4 per cent; $\frac{1}{10}$ inch to ¼ inch, 9.2 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 22.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 26 per cent; through $\frac{1}{40}$ inch, 40.2 per cent. Kind of binder, water-gas pitch; laboratory No. 3486 (see p. 40). Weight of fuel briquetted, 24,000 pounds. B. t. u. per pound of fuel as received, 10,106; per pound of briquets as fired, 10,994; per pound of binder, 16,407.

English briquets made at 179° F., average weight 3.18 pounds, with 5, 6, 7, 8, and 10 per cent of binder, would not cohere; all the briquets could be crushed in the hand. In the weathering test they were exposed 180 days; condition of those with 5 and 6 per cent binder, D; of those with 7 and 8 per cent binder, E.

Drop test.

Percentage of binder	5	6	7	8
Held by 1-inch screen	35.4	61.3	74	79
Passed 1-inch screen	64.6	38.7	26	21

Renfrow briquets made at 149° F., average weight 0.42 pound, with 7, 8, and 10 per cent binder, were not improved by increase in percentage of pitch; all briquets were bad and could be crushed in the hand. Weathering test, exposed 180 days, condition E. For analyses of briquets see page 287 (steaming test 419).

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 134.
Laboratory No.	3486	3390	.....
Air-drying loss.....per cent.	.....	11.30	4.90
Extracted by CS_2:			
Air-dried.....do....	.....	.94	6.12
As received.....do....	85.57	.83	5.82
Pitch in briquets, as received.....do....	.....	.....	6.13

MISCELLANEOUS TESTS.

MISCELLANEOUS COKE.

Fuel designated miscellaneous coke was used in producer-gas test 151.

PRODUCER-GAS TEST.

Miscellaneous coke.

Test 151.—Duration of test, 41 hours. Average electrical horsepower, 199.5. Average B. t. u. per cubic foot of gas, 120.6. Total coal fired, 8,400 pounds.

	Coal as fired.	Dry coal.	Combustible.
Coal consumed in producer per horsepower hour (pounds).			
Per electrical horsepower:			
Commercially available	1.03	0.95	0.83
Developed at switchboard	1.03	.95	.83
Per brake horsepower:			
Commercially available	.87	.80	.70
Developed at engine	.87	.80	.70

Analyses.

Coal.		*Gas by volume.*	
Moisture	7.86	Carbon dioxide (CO_2)	9.2
Volatile matter	.69	Carbon monoxide (CO)	21.9
Fixed carbon	79.94	Hydrogen (H_2)	11.1
Ash	11.51	Methane (CH_4)	0.2
Sulphur	1.14	Nitrogen (N_2)	57.5
		Ethylene (C_2H_4)	.1

MIXED COKE.

Fuel taken from a pile containing a mixture of the products of the coking tests was designated mixed coke. This sample was used in steaming test 519, to determine the effect of the absence of volatile matter in fuel on the completeness of combustion.

CHEMICAL ANALYSES.[a]

Mixed coke.

Proximate:		Ultimate:	
Moisture	6.55	Hydrogen	0.57
Volatile matter	.81	Carbon	81.34
Fixed carbon	79.78	Nitrogen	.89
Ash	12.86	Oxygen	2.40
Sulphur	.97	Ash	13.76
		Sulphur	1.04

STEAMING TEST.

Mixed coke.

	Test 519.
Duration of test, hours	8.92
Heating value of fuel, B. t. u. per pound dry fuel	12,366
Force of draft:	
Under stack damper, inch water	0.89
Above fire, do	.07
In ash pit, do	.25
Furnace temperature, °F	2,560
Dry fuel used per square foot of grate surface per hour, pounds	27.92
Equivalent water evaporated per square foot of water heating surface per hour, do	4.65
Percentage of rated horsepower of boiler developed	130.3
Water apparently evaporated per pound of fuel as fired, pounds	6.44
Water evaporated from and at 212° F.:	
Per pound of fuel as fired, do	7.80
Per pound of dry fuel, do	8.35
Per pound of combustible, do	10.00
Efficiency of boiler, including grate, per cent	65.21
Fuel as fired:	
Per indicated horsepower hour, pounds	3.63
Per electrical horsepower hour, do	4.48
Dry fuel:	
Per indicated horsepower hour, do	3.39
Per electrical horsepower hour, do	4.18

ILLINOIS, COLLINSVILLE.

Nut coal from Collinsville, Ill., was purchased, uninspected, by the Government for special steaming tests to determine the best method of firing Illinois coal, as follows: Test 500, alternate method of firing; test 501, spreading method; test 502, coking method; test 503, ribbon method (firing alternately in narrow strips across the full length of the grate); test 504, alternate method; and test 505, alternate

[a] Steaming test 519. Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

method with forced draft. This fuel was also used in test 517 to determine the effect of reduced grate area on efficiency.

CHEMICAL ANALYSES.

Illinois, Collinsville.

	Steaming tests.[a]						
	500.	501.	502.	503.	504.	505.	517.
Proximate:							
Moisture	12.59	13.08	14.00	14.05	10.80	13.60	11.98
Volatile matter	35.94	35.34	33.85	33.64	36.76	35.17	35.11
Fixed carbon	42.34	42.62	42.43	41.37	42.81	41.51	43.83
Ash	9.13	8.94	9.70	10.94	9.63	9.72	9.08
Sulphur	3.24	3.16	3.36	3.35	3.31	3.22	2.85
Ultimate:							
Hydrogen	4.95	4.97	4.90	4.81	4.93	4.91	4.99
Carbon	70.33	70.51	69.48	68.30	70.03	69.65	70.81
Nitrogen	1.11	1.12	1.09	1.08	1.11	1.10	1.11
Oxygen	9.46	9.47	9.34	9.18	9.42	9.36	9.53
Ash	10.44	10.29	11.28	12.73	10.80	11.25	10.32
Sulphur	3.71	3.64	3.91	3.90	3.71	3.73	3.24

[a] Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

STEAMING TESTS.

Illinois, Collinsville (nut).

	Test 500.	Test 501.	Test 502.	Test 503.	Test 504.	Test 505.	Test 517.[a]
Duration of test.....hours	9.02	6.42	8.82	7.27	6.37	7.37	6.33
Method of firing	Alternate.	Spreading.	Coking.	Ribbon.	Alternate.	Alternate.	
Heating value of coal, B. t. u. per pound dry coal	12,586	12,823	12,649	12,434	12,739	12,670	12,861
Force of draft:							
Under stack damper.....inch water	0.93	0.64	0.85	0.91	0.91	0.99	0.50
Above fire.....do	.22	.16	.12	.14	.19	.13	.27
In ash pit (forced draft).....do						.25	
Furnace temperature.....°F.	2,555	2,531	2,158	2,552	2,484	2,755	
Dry coal used per square foot of grate surface per hour.....pounds	25.10	22.17	21.87	24.49	24.17	30.36	28.77
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	4.00	3.31	3.39	3.81	3.59	4.69	2.31
Percentage of rated horsepower of boiler developed	112.1	92.7	95.0	106.7	100.8	131.6	64.6
Water apparently evaporated per pound of coal as fired.....pounds	5.75	5.34	5.50	5.51	5.49	5.52	5.82
Water evaporated from and at 212° F.:							
Per pound of coal as fired.....pounds	6.98	6.49	6.67	6.69	6.64	6.69	7.06
Per pound of dry coal.....do	7.99	7.47	7.76	7.78	7.45	7.74	8.02
Per pound of combustible.....do	9.10	8.52	8.93	9.18	8.46	8.90	9.41
Efficiency of boiler, including grate, per cent	61.31	56.26	59.24	60.42	56.48	58.99	60.22
Coal as fired:							
Per indicated horsepower hour.pounds	4.05	4.36	4.24	4.23	4.26	4.23	4.01
Per electrical horsepower hour....do	5.00	5.38	5.23	5.22	5.26	5.22	4.94
Dry coal:							
Per indicated horsepower hour....do	3.54	3.79	3.64	3.63	3.80	3.65	3.53
Per electrical horsepower hour....do	4.37	4.67	4.50	4.49	4.69	4.51	4.35

[a] Grate area reduced to 20.3 square feet.

WASHERY REFUSE.

Fuel taken from the dumping pile of the coal washery of the fuel-testing plant was designated washery refuse. This sample was composed of the dumpings of many bituminous coals and had been exposed several months before it was taken up for test. Steaming test 479 was made on it to determine whether such refuse can be used for steaming purposes.

CHEMICAL ANALYSES.[a]

Washery refuse.

Proximate:		Ultimate:	
Moisture	10.83	Hydrogen	2.83
Volatile matter	17.21	Carbon	39.81
Fixed carbon	30.14	Nitrogen	.68
Ash	41.82	Oxygen	7.09
Sulphur	2.40	Ash	46.90
		Sulphur	2.69

STEAMING TEST.

Washery refuse.

	Test 479.
Size as used:	
Over 1 inch ..... per cent	5.6
½ inch to 1 inch ..... do	13.8
¼ inch to ½ inch ..... do	16.6
Under ¼ inch ..... do	64.0
Average diameter ..... inch	.38
Duration of test ..... hours	7.18
Heating value of coal ..... B. t. u. per pound of dry coal	7,241
Force of draft:	
Under stack damper ..... inch water	.92
Above fire ..... do	.06
In ash pit (forced draft) ..... do	.73
Dry coal used per square foot of grate surface per hour ..... pounds	3,645
Equivalent water evaporated per square foot of water-heating surface per hour ..... do	2.59
Percentage of rated horsepower of boiler developed	72.6
Water apparently evaporated per pound of coal as fired ..... pounds	2.63
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... do	3.17
Per pound of dry coal ..... do	3.56
Per pound of combustible ..... do	8.06
Efficiency of boiler, including grate ..... per cent	47.48
Coal as fired:	
Per indicated horsepower hour ..... pounds	8.92
Per electrical horsepower hour ..... do	11.01
Dry coal:	
Per indicated horsepower hour ..... do	7.94
Per electrical horsepower hour ..... do	9.81

MISCELLANEOUS NO. 5.

A sample of coke breeze was furnished by a gas company for use in briquetting tests 152 and (mixed with Tennessee No. 4, p. 234) 150 and 151. One sample (No. 3386) was taken for chemical analysis.

CHEMICAL ANALYSES.

Miscellaneous No. 5 (coke breeze).

	Sample.	Briquetting test 152.[b]
Laboratory No.	3386	3385
Air-drying loss	8.80	.....
Moisture	10.72	5.01
Volatile matter	4.08	10.70
Fixed carbon	73.25	72.05
Ash	11.95	12.24
Sulphur	1.02	1.05
Calorific value determined (as received) ..... calories	6,131	.....
Calorific value determined (as received) ..... B. t. u.	11,036	.....

[a] Steaming test 479. Proximate analysis of fuel as fired; ultimate analysis of dry fuel figured from car sample.

[b] Proximate analysis of fuel as received; no ultimate analysis of briquets was made.

BRIQUETTING TEST.

Miscellaneous No. 5 (coke breeze).

Test 152.—Size as used: Over ¼ inch, 2.8 per cent; $\frac{1}{10}$ inch to ¼ inch, 11 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 21.2 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 30.4 per cent; through $\frac{1}{40}$ inch, 34.6 per cent. These briquets were very soft when warm, giving nearly 25 per cent breakage in falling from delivery belt of machine and in handling with coke forks. They could not be piled satisfactorily while warm. When cold, they had a rough, hard surface, with coating of brown from the dies, and broke without crumbling, giving a rough fracture surface.

Details of manufacture:		Drop test (1-inch screen):	
Machine used	Renf.	Held ..... per cent	60.5
Temperature of briquets ..... ° F	149	Passed ..... do	39.5
Binder—		Tumbler test (1-inch screen):	
Kind	w. g. k.	Held ..... do	72.5
Laboratory No. (see p. 40)	3410	Passed (fines) ..... do	27.5
Amount ..... per cent	8	Fines through 10-mesh sieve ..... do	90.0
Weight of—		Weathering test:	
Fuel briquetted ..... pounds	20,000	Time exposed ..... days	198
Briquets, average ..... do	0.437	Condition	A.
Heat value per pound—		Water absorption:	
Fuel as received ..... B. t. u.	11,036	In 15 days ..... per cent	20.6
Fuel as fired ..... do	12,119	Average for first 5 days ..... do	2.64
Binder ..... do	16,478	Specific gravity (apparent)	1.030

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 152.
Laboratory No	3410	3386	3385
Air-drying loss ..... per cent	.....	8.70	3.10
Extracted by CS_2:			
Air dried ..... do	.....	.65	6.96
As received ..... do	79.98	.59	6.74
Pitch in briquets as received ..... do	.....	.....	7.75

MISCELLANEOUS NO. 9.

The sample designated Miscellaneous No. 9 consisted of coke breeze which was shipped from a plant in Madison, Ill.

This sample was used in briquetting tests 247 [a] and 249; also mixed with Pennsylvania No. 18 in briquetting tests 238†, 239†, 240†, and 248. (See pp. 211–213.)

One car sample (No. 4763) was taken for chemical analysis.

CHEMICAL ANALYSES.

Miscellaneous No. 9 (coke breeze).

	Sample.	Briquetting tests 247, 249. [b]
Laboratory No	4763	4827
Air-drying loss	1.30	1.30
Moisture	1.95	2.61
Volatile matter	.89	10.71
Fixed carbon	75.50	58.55
Ash	21.66	28.13
Sulphur	.66	.98
Calorific value determined (as received) ..... calories	6,039	5,514
Calorific value determined (as received) ..... B. t. u.	10,870	9,925

[a] The briquets made in this test were used in a special cupola test; see p. 45.
[b] Proximate analysis of fuel as received; no ultimate analysis of briquets made.

BRIQUETTING TESTS.

Miscellaneous No. 9 (coke breeze).

Test 247.—Size as used: Over ¼ inch, 2.2 per cent; $\frac{1}{10}$ inch to ¼ inch, 8 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 15 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 25.6 per cent; through $\frac{1}{40}$ inch, 49.2 per cent. Attempts to briquet coke breeze with unslacked lime as a binder were unsatisfactory. Briquets were made by the addition of pitch to the lime, and showed when warm characteristics similar to those of the briquets made in test 249. The cold briquets, however, were much harder and continued to increase in hardness for several weeks. The hardened briquets had a smooth outer surface and a rough, hard fracture surface, with firm edges.

Test 249.—Size as used: Over ¼ inch, 1.6 per cent; $\frac{1}{10}$ inch to ¼ inch, 7.6 per cent; $\frac{1}{20}$ inch to $\frac{1}{10}$ inch, 15.8 per cent; $\frac{1}{40}$ inch to $\frac{1}{20}$ inch, 25.8 per cent; through $\frac{1}{40}$ inch, 49.2 per cent. The characteristics of these briquets are similar to those noted in the report of test 248 (p. 212). These briquets had a coating of bronze from the dies, which showed perceptibly the erosive effect of the coke. Satisfactory briquets were made with 8 per cent binder, and no increase in cohesion was observed by increasing this percentage.

	Test 247.[a]	Test 249.		Test 247.[a]	Test 249.
Details of manufacture:			Drop test (1-inch screen):		
Machine used	Renf.	Renf.	Held.....per cent..	66.0	67.0
Temperature of briquets..	176	158	Passed.....do....	34.0	33.0
Binder—			Tumbler test (1-inch screen):		
Kind	(b)	w. g. p.	Held.....per cent..	86.5	79.5
Laboratory No. (see p. 40)	4879	4879	Passed (fines).....do....	13.5	20.5
Amount....per cent..	8 each.	8	Fines through 10-mesh sieve.....per cent..	65.0	81.0
Weight of—			Water absorption:		
Fuel briquetted, pounds	6,000	2,000	In 23 days.....per cent..	.....	18.8
Briquets, average, pound	0.642	0.520	In 10 days.....do....	10.0	.....
Heat value per pound—			Average for first—		
Fuel as received, B. t. u	10,870	10,870	6 days. .....do....	1.50	.....
Fuel as fired..B. t. u..	9,925	.....	5 days.....do....	.....	2.60
Binder.....do....	16,805	16,805	Specific gravity (apparent)..	1.287	1.178

[a] The briquets made in this test were used in a special cupola test; see p. 45.
[b] Water-gas pitch and unslacked lime, 8 per cent each.

Extraction analyses.

	Pitch.	Fuel.	Briquets, test 247.
Laboratory No.	4879	4763	4827
Air-drying loss,.....per cent..	.....	1.30	1.30
Extracted by CS_2:			
Air dried.....do....	.....	.15	7.32
As received.....do....	94.50	.15	7.22
Pitch in briquets as received.....do....	.....	.....	7.50

MISCELLANEOUS NO. 10.

Coal designated Miscellaneous No. 10 was used in washing test 177.

WASHING TEST.

Miscellaneous No. 10 (slack).

Test 177.—Jig used, Stewart. Raw coal, 56,560 pounds. Washed coal, 40,160 pounds; 71 per cent. Refuse, 16,400 pounds; 29 per cent.

Analyses.

	Raw coal.	Washed coal.
Moisture	6.67	11.06
Volatile matter	31.61	.....
Fixed carbon	51.19	.....
Ash	10.53	6.38
Sulphur	1.55	1.30

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