crushed or slack coal. Some of the earlier designs, however, were constructed to handle run-of-mine coal. A number of these stokers are still in operation on passenger locomotives on the Chesapeake and Ohio Ry. The tabulation shown as a part of this report is sufficient evidence that the locomotives so equipped are coming and going daily (many in pool service), performing the work expected of them, and the proper operation of the stokers with which the locomotives are equipped is left to the crews to which they are assigned. A better idea of the service and failures may be obtained from the tabulation.

CRAWFORD STOKER.—Beyond the continued improvement in detail parts, the Crawford underfeed stoker seems to be adhering closely to its original principle of construction. The record shows that there are at present 301 in service, all applied to locomotives on the Pensylvania Lines West of Pittsburg, except two on the Pennsylvania Lines East of Pittsburg. From all reports they are working satisfactorily. The machine, as previously described, handles run-of-mine coal, producing its best results using the higher volatile products. The report from the Pennsylvania Rd. is to the effect that they are closely observing the everyday performance of the stokers in service, so as to ascertain under which the highest efficiency is obtained, and incidentally are educating men to handle and control them to the best advantage.

THE HANNA STOKER is another of the scatter type, but handles run-of-mine coal, as described in detail in last year's report. It continues to perform its work satisfactorily, according to reports. The records show that to date there are three in operation—one on a Mallet locomotive on the Carolina, Clinchfield and Ohio; another on a mikado on the Queen and Crescent, and the third on a class M2 (4-8-0 type) locomotive on the Norfolk and Western. We are informed that there are six additional stokers to be applied to Mallet locomotives on the Carolina, Clinchfield and Ohio, and 15 to the same type locomotive on the Norfolk and Western.

STANDARD STOKER.—Your committee's last report mentioned all stokers concerning the operation of which information had been secured. Since that time some tests of the Standard stoker have been made on the New York Central Lines, in heavy freight service, and the reports so far seem to be quite promising. The company manufacturing the stoker, like other designers, seems to be satisfied that it is working along the right lines, and such may be the case, but time and trial only can determine if it is right. A special feature claimed for the stoker is the elimination of all parts from the engine cab and deck, and the use of run-of-mine coal without previous treatment or selection. The coal is reduced to the required size by an arrangement of the feeding screw, thus eliminating the necessity of a separate crusher. As the coal gravitates to the horizontal screws it is delivered to a point about the centre of the firebox—but at the back end—where another screw, in a vertical position, elevates the fuel to a sufficient height, where it is blown by steam over the fire bed. The machine is actuated by a turbine engine, which is also a departure from the conventional lines followed in other designs. A second stoker of the Standard type has been put on a Mallet locomotive in service on the New York Central, and three more have been secured for experimental purposes on the Norfolk and Western. Two of the latter machines will be applied to heavy freight locomotives of the 4-8-0 type, and the third to a heavy passenger locomotive. The Standard stoker, like the Hanna and Crawford, differs from the Street in that it handles run-of-mine coal, whereas the Street, as now constructed, requires prepared or slack fuel.

AYERS STOKER.—Within the past year some very interesting work has been done by A. R. Ayers, General Mechanical Engineer of the Lake Shore and Michigan Southern, toward the utilization of the chain grate, as we understand it. Your committee is not familiar with the details of the design, nor the progress thus far made, but understands it is not quite ready for application. The idea indeed is interesting, and is a principle your committee believes well worth exploiting. The Standard and Ayers, if we may so designate the latter, seem to represent the most prominent work in the stoker field during the past year.

BREWSTER STOKER.—No reports of further development of this stoker have been received during the year. The statement has been made that its patents have been taken up by the Standard Stoker Co.

STROUSE STOKER.—While nothing definite has been learned concerning any new developments in this stoker during the past year, it has been said that a son of the original inventor is working on the design.

GEE STOKER.—But one stoker of this design has been built to date. It is still in service on a class H-6 (2-8-0) locomotive on the Pennsylvania Lines East, and is reported as giving good results. It is still considered in an experimental stage.

ELVIN STOKER.—With the construction of a full size working model of this stoker, which is now ready for application, a distinctly new principle is offered. While it properly belongs to the "scatter" or "overfeed" group, it may be referred to as the shovel type in contradistinction to the rest. The machine is attached to a casting similar to, and is bolted to, the back head of the boiler—the same manner as the fire door front. It is made up of two shovels, one operating to the right and the other to the left; under full control, distributing coal regularly and evenly over the bed of the fire, as might be expected under expert hand firing. The drum, or stoker mechanism, operates at 20 r.p.m., when shoveling 12,000 lbs. of coal per hour. The operation is entirely mechanical, no steam being used in distributing the coal.

THE RAIT STOKER is a patent of G. B. Rait, of Minneapolis. Your committee has not seen any working drawings, but understands from the inventor that most of the machinery is below the deck of cab. It is also mentioned as an interesting feature that it can be handled as either an underfeed or a scatter type. As yet there is none in operation. We further understand from the inventor that he has some new designs and improvements pending in the Patent Office, and will soon have working drawings ready for exhibition. This stoker is therefore undergoing development.

BARNUM, DICKERSON, ERIE, HAYDEN, Hayden modified, McMullen, Harvey, Hervey and Kincaid.—It cannot be ascertained that there are any of these stokers in service, or that anything has developed concerning them during the past year.

The Norfolk and Western Ry. submits the following performance figures for the Street stoker: All failures chargeable to stokers: Machinery failures in fair service, 43; failures due to flaws and defects in machinery, 4; failures due to machine becoming clogged with foreign matter, 31; shop or bad workmanship failures, 19, crew failures, or failures due to improper handling, resulting in low steam, 48; failures due to improper lubrication as a lack of attention, 20; total failures, 165; total mileage made by locomotives equipped with stokers, 2,296,803; total stoker failures as above, 165; miles per stoker failure, 13,920; total cost for labor and material chargeable to stokers, $12,-179.22; and cost of stoker repairs per 100 miles, cents, 0.53. Locomotives 1303 and 1311 have not as yet had a stoker failure charged to them, having made 36,089 miles and 35,778 miles, respectively, since the locomotives were put in service new in April, 1912.

The Baltimore and Ohio Rd. reports that the Street stokers in service on that road are making 44,300 miles per failure chargeable to the stoker proper. It may be of interest to mention in connection with the apparent difference in the figures submitted by the Baltimore and Ohio and the Norfolk and Western showing mileage per stoker failure, that the Baltimore and Ohio figures are computed on the basis of the number of machinery failures in fair service and does not include delays caused by the stoker not being properly operated by the engine crews. On the same basis, as can be quickly seen by referring to the tabulation, the mileage per failure on the Norfolk and Western would be equal to 53,414 miles, which is very close.

The following data are submitted by the Pennsylvania Lines West, giving some interesting information in connection with the performance of the Crawford stoker, including all trips of all stokers from the experimental installation to this date:

	As reported Jan. 1913.	As reported Jan. 1914.
Total no. of trips	26,693	98,181
No. of trips—100%	16,445	55,913
" of trips— 99%	262	335
" of trips— 98%	402	723
" of trips—95-98%	1,367	3,865
" of trips—90-95%	1,577	5,352
" of trips—85-90%	560	1,861
" of trips—80-85%	715	2,963
" of trips—75-80%	962	4,086
" of trips—70-75%	305	1,306
" of trips below 70% ...	4,098	21,787

The Norfolk and Western submits the following data for the Hanna stoker: Put in service, Feb. 11, 1914; days in service, 48; trips, 37; 100% or successful trips, 32, or 86%; and failures on road requiring hand firing for a portion or completion of trip to be made pending repairs to be made, 5.

During 1912 there were 165 Street stokers in operation. During 1913 there were 253 additional stokers installed, making a total of 418 in operation. They are distributed as follows:

ROAD.	Consolidation.	Mallet.	Mikado.	Mountain pass.	Decapod.	Centipede.	Pac. pass.	Total.
L. S. & M. S...	..	3	..	..	..	..	..	3
N. & W.	2	90	..	..	..	..	..	92
C. & O.	..	14	50	3	..	..	6	73
B. & O.	1	24	161	..	1	..	..	193
Virginian	..	6	1	..	..	..	..	7
B. R. & P.	..	5	1	..	..	..	..	6
H. V.	..	..	17	..	..	..	..	17
A. T. & S. F. ...	..	1	..	..	..	..	..	1
D. M. & N	..	8	..	..	..	..	..	8
E. P. & S. W. ..	1	..	5	..	..	..	..	6
C. B. & Q.	..	..	1	..	12	..	..	13
Erie	..	..	..	..	..	1	..	1
Total	4	155	236	3	13	1	6	418

During 1912 the Pennsylvania Rd. Lines West of Pittsburg had 153 double underfeed Crawford stokers in operation. The Pennsylvania Lines East of Pittsburg had 2, making a total of 146. During 1913, 155 additional stokers were applied, making a total of 301:

Type of stoker.	Class of locomotives.	Reported Jan. 1913.	Reported Jan. 1914.
12	K2	1	1
12	K2as	26	26
12	K3s	..	30
13	H8c	10	10
13	H8cs	1	1
14	H6a	5	5
15	H6a-b	20	20
16	H6a	1	1
17	H8c	1	1
19	B29	1	1
22	H8c	54	54