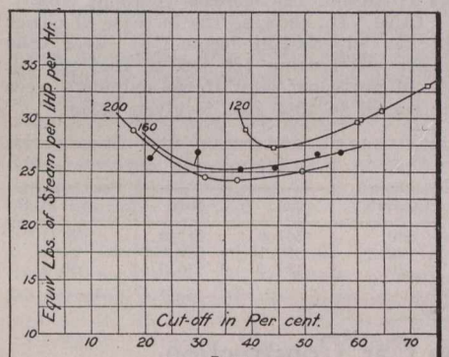
the saturated steam.

PERFORMANCE OF THE BOILER. — The equivalent evaporation per square foot of water and superheating equation for the line as shown, which most nearly approximates all the points, is E=12.443−.319 H; where E is the equivalent evaporation per pound of dry coal and

Table 4.

Number	Laboratory Symbol	Equiv. Steam for Engine per Hour Feed Water 60° F.	Equiv. Evap. per pound of dry Coal E=12.443-.319H	Dry Coal fired per Hr. Corr. by Equation	Dry Coal per Sq. Ft. Grate Surface per Hr. Pounds	Dry Coal per I.H.P. per Hr.	Equiv. Steam per I.H.P. per Hr.	Machine-Friction: Mean Effective Pressure	Machine-Friction: Indicated Horse Power	Machine-Friction: Per Cent I.H.P.	Dynamometer Horse-Power	Draw-Bar Pull	Coal per Dyna Horse Power per Hr.	Equiv. Steam per Dyna Horse Power per Hour
I	II	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	XXV	XXVI	XXVII
1	30—2—200	8397	10.50	800	47.1	2.76	28.94	6.5	46.5	16.00	243.7	3017	3.28	34.45
2	30—4—200	10737	9.96	1078	63.4	2.46	24.50	8.5	60.2	13.70	377.9	4706	2.85	28.42
3	30—6—200	12817	9.51	1348	79.4	2.55	24.25	9.3	65.2	12.30	463.3	5840	2.91	27.67
4	30—9—200	17435	8.48	2056	120.9	2.95	25.04	7.7	54.7	7.90	641.7	8018	3.20	27.17
5	30—4—160	8349	10.53	793	46.6	2.50	26.32	6.5	45.7	14.40	271.5	3415	2.92	30.75
6	30—6—160	10060	10.11	995	58.5	2.53	26.91	8.5	60.2	15.30	333.8	4162	2.98	30.14
7	30—8—160	12372	9.61	1287	75.7	2.62	25.22	9.3	65.7	13.40	425.0	5320	3.03	29.12
8	30—9—160	13835	9.30	1480	87.5	2.73	25.41	7.7	54.0	9.90	490.4	6217	3.03	28.21
9	30—11—160	16424	8.71	1886	110.9	3.07	26.70	6.0	42.6	6.90	572.5	7161	3.29	28.69
10	30—12—160	17272	8.52	2027	119.2	3.15	26.84	5.0	34.2	5.30	609.3	7917	3.33	28.35
11	30—8—120	9932	10.20	974	57.3	2.84	28.94	8.4	59.5	17.30	283.6	3533	3.43	35.02
12	30—10—120	11456	9.81	1168	68.7	2.78	27.30	6.9	48.5	11.70	371.2	4666	3.15	30.80
13	30—14—120	15183	8.98	1691	99.5	3.31	29.69	3.0	21.2	4.20	490.2	6112	3.45	30.98
14	30—15—120	16399	8.72	1881	110.6	3.43	29.88	3.0	22.2	4.00	526.6	6334	3.57	31.14
15	30—16—120	16436	8.71	1887	111.0	3.52	30.68	3.0	21.3	4.00	514.4	6311	3.67	31.95
16	30—18—120	18186	8.31	2188	128.7	3.97	33.03	3.0	21.2	3.90	529.4	8123	4.13	34.35



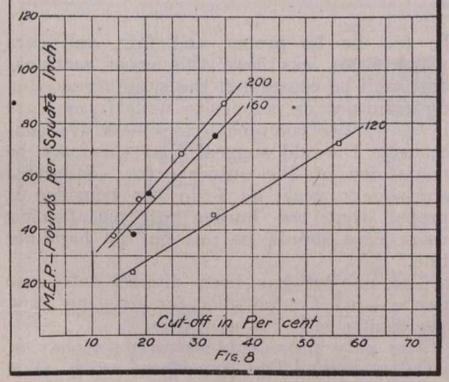


Fig. 7.—Relation Between Equivalent Pounds of Steam per i.h.p. Hour and Cutoff for Superheated Steam Locomotive.

Fig. 8.—Relation Between m.e.p. and Cutoff for Saturated Steam Locomotive.

H is the equivalent evaporation per square foot of water and superheating surface per hour. The area of the heating surface is based upon the interior surface of the fire box and the exterior surface of the boiler and superheating tubes. This equation was derived from all tests at all pressures and therefore fairly represents the average performance of the boiler at any pressure when operated under superheated steam. It is a noteworthy fact that this equation is practically the same as that obtained from the lower rates of firing reported to the Association in 1911. The equation for the nine points as obtained that year was E = 12.450 — .318 H. In the same manner as used in the original locomotive, G equals the dry coal per sq. ft. of grate surface per hour, 1,404 the number of sq. ft. of water and superheating surface, 17 the number of sq. ft. of grate surface and H and E the same as before mentioned, the following formula is true: $1{,}404\ H = 17\ 17\ E\ G$, $E\ G$, or $H = \frac{}{1{,}404}$

Substituting this value of H in the equation E = 12.443 — .319 H, we obtain

$$E = \frac{3{,}221}{G + 258.9}$$

the equation E = ————, which shows the relation between the equivalent evaporation per pound of dry coal and the dry coal per sq. ft. of grate surface per hour when using superheated steam. The graphical representation of this equation is shown in fig. 5.

PERFORMANCE OF THE SUPERheater Locomotive, assuming irregularities to have been eliminated.—Table IV. shows the performance of the locomotive when using superheated steam, assuming irregularities to have been eliminated. The results in this table were obtained in exactly the same manner as those from the locomotive when using saturated steam as shown in table II., and may be compared with them.

The Increase of Power of the Superheater Locomotive.

Having now obtained the values as shown in tables II. and IV. for the two types of locomotives, the curves as shown in figs. 6 to 9 were plotted. By the use of the equations of the curves in figs. 2 and 5, the equivalent pounds of steam per pound of coal can be determined for any rate of firing of either locomotive. Also, from figs. 6 and 7, the equivalent pounds of steam per i. h. p. per hour can be determined for any cut off, and from the lines shown in figs. 8 and 9 the mean effective pressure for any cut off can be ascertained. Now, assuming that the curves as shown in these figures fairly represent the performance of each locomotive, it is possible to obtain the performance of each locomotive at the same rate of firing—that is, burning the same number of pounds of coal per sq. ft. of grate area per hour. Table V. shows this comparison of the two locomotives while burning 110, 120 and 130 lbs. of coal per square foot of grate.

Table 5.

Dry Coal per Sq. ft. of Grate Surface per Hour	Steam Pressure	Equiv. Evap. per Pound of Dry Coal: Sat.	Equiv. Evap. per Pound of Dry Coal: Sup.	Equiv. Pounds of Steam per Hour: Sat.	Equiv. Pounds of Steam per Hour: Sup.	Cut-Off in Per cent: Sat.	Cut-Off in Per cent: Sup.	Equiv. Pounds of Steam per I.H.P. per Hr.: Sat.	Equiv. Pounds of Steam per I.H.P. per Hr.: Sup.	M.E.P. Lbs. per Sq. In.: Sat.	M.E.P. Lbs. per Sq. In.: Sup.	Indicated Horse Power: Sat.	Indicated Horse Power: Sup.	Percent Increase in I.H.P.
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
110	200	8.61	8.73	16100.7	16325.1	29.5	48.1	30.1	24.9	75.3	92.4	534.8	655.8	22.6
110	160	8.61	8.73	16100.7	16325.1	32.3	52.4	30.7	26.4	73.8	87.1	524.3	618.4	18.0
110	120	8.61	8.73	16100.7	16325.1	49.9	63.05	34.7	30.3	65.4	75.8	464.2	538.5	16.0
120	200	8.43	8.50	17197.2	17340.0	31.6	50.9	30.3	25.2	80.0	96.9	567.8	688.1	21.2
120	160	8.43	8.50	17197.2	17340.0	34.3	55.5	31.1	26.7	77.9	91.5	553.1	649.6	17.5
120	120	8.43	8.50	17197.2	17340.0	52.5	65.95	35.3	31.1	68.6	78.5	487.2	557.5	14.4
130	200	8.25	8.28	18232.5	18298.8	33.4	53.2	30.5	25.5	84.2	101.0	597.8	717.4	20.0
130	160	8.25	8.28	18232.5	18298.8	36.0	58.2	31.5	27.1	81.5	95.1	578.8	675.2	16.7
130	120	8.25	8.28	18232.5	18298.8	54.9	68.7	35.8	31.8	71.7	81.0	509.2	575.3	13.0

Table 6.

Superheater Engine 120# Dry Coal Per Sq. Ft. of Grate Surface per Hour

Steam Pressure	Cut-Off in Percent of Stroke	Equiv. Lbs. of Steam per I.H.P. per Hr.	M.E.P. Pounds per Sq. Inch	Cut-Off at Maximum Efficiency	Equiv. Lbs. of Steam per I.H.P. per Hr. at Maximum Efficiency	M.E.P. at Maximum Efficiency	Percent Increase in I.H.P.	Diam. of Cyl. in Inches to give Maximum Efficiency
I	II	III	IV	V	VI	VII	VIII	IX
200	50.9	25.2	96.9	35.0	24.2	70.0	3.97	18.82
160	55.5	26.7	91.5	37.0	25.2	66.7	5.62	18.73
120	65.95	31.1	78.5	44.0	27.3	58.0	12.22	18.62

surface per hour and the equivalent evaporation per pound of dry coal, columns VI. and VII. in table III., were plotted as shown in fig. 4. There were 16 different tests run under superheated steam, and, as shown, each point represents one test. The

Column I. of this table shows the rate of firing per sq. ft. of grate per hour.

Column II. gives the steam pressure, the comparisons being made at three pressures, namely, 200, 160 and 120.

Column III. gives the equivalent evaporation per pound of dry coal for the original locomotive, and was obtained by substituting the values in col. 1 for G in the

$$E = \frac{3{,}978}{G + 351.9}$$

equation E = ————

Column IV. gives the equivalent evaporation per pound of dry coal for the superheater locomotive, and was obtained by substituting the values in column I for G

$$E = \frac{3{,}221}{G + 258.9}$$

in the equation E = ————

Column V. gives the equivalent pounds of steam per hour for the ordinary locomotive, and was obtained by multiplying the values in column I. by those in column III. and then by 17.

Column VI. gives the equivalent pounds of steam per hour for the superheater locomotive, and was obtained by multiplying