C. E. MEYERS

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THESIS.

TEST OF BOILER AND ENGINE

AT THE PORTLAND FLOUR MILL

C. E. Meyers. 1896.

THESIS

Main Collins

Steam engines

T H E S I S.

Report of a Test of Boiler and Engine

at The Portland Flour Mill.

by

O. E. Myers,

June 7th, 1900.

THESIS

REPORT OF A TEST OF BOILER AND ENGINE

AT THE PORTLAND FLOUR MILL.

On June 20, 1898, tests were made on the boiler and engine at the Portland flour mill, for the purpose of determining the coal used in the manufacture of a barrel of flour, also the horse powers developed per barrel of flour, and the steam consumption of the engine, and efficiency of the boiler under usual running conditions.

The engine is a tandem compound condensing engine, built by the Lansing Iron and Engine Works. The boiler was originally designed for the low pressure side of a cross compound engine. The engine is automatically governed. The low valves, which are quadruple ported slide valves with pressure plates, are both operated by the same eccentric. Both cylinders are provided with wood lagging.

The condenser is a Blower jet condenser, and takes its condensing water from the river. (Cut of Condenser).

A Frost steam pump takes its water from the condenser and delivers it through a system of piping in a Mansel water heater, through which the exhaust passes on its way to the condenser, to the live steam purifier, from which it flows by Gravitation to the boiler.

The boiler is of the water tube type, built by Abendroth & Root, and was installed in 1888. (Cut of Boiler).

102692

The steam pipes are covered with several layers of wrapping paper, affording [illegible] protection from radiation.

The calorimeter used during the test was a Peabody throttling calorimeter. The samples of steam were taken from the vertical pipe leading to the [illegible], just above the valve. The steam was taken by means of a long 1-2 inch nipple with small holes drilled in it, and extending across the flow of steam.

The indicator motion used is illustrated at the end of the report. It consists of a rod, AB., pivoted to the cross head at B. working in the [illegible] in the tube CL. which is pivoted at C. and carries a movable piece E., to which is attached the cord passing over the pulley F. to the Taber indicators used during the test. The reduced motion is not absolutely correct, but it gives a very close approximation, and compares favorably with the motion obtained from the well known Thurston pulley.

The thermometers used for obtaining the temperatures were made by Queen, and were all marked with the centigrade scale, with the exception of the one used flue gases and the one in the calorimeter, which were Farenheit.

The first three items of the following table of dimensions were obtained from the builder, and as they were carroborated by the engineer in charge, I have used them, without taking the measurements myself.

Diameter high pressure cyl.	[illegible]	in.
" low " "	[illegible]	in.
Length of stroke	[illegible]	in.
Piston displacement, per min., high pressure	8891.0	cu. in.
" " " " low "	8132.3	" "
" " head " high "	6847.6	" "
" " crank " " "	6838.4	" "
Area piston, high pressure, head end	113.04	sq. in.
" " " " crank "	103.11	" "
" " low " head "	342.33	" "
" " " " crank "	340.43	" "
Area high pressure rod, 2-1/4" diameter	3.975	" "
" low " " " 2-3/4" "	5.940	" "

Method of Conducting the Test.

In the morning when everything was in readiness, the fires were observed and the test started at 7:47.

For use during the test, a Worthington steam pump was loaned to us by the Battle Creek Steam Pump Co. This was so placed that it took its feed water from the condenser and delivered it to the weighing tanks. The Frost pump was piped to take the water from the tank and deliver it to the purifier. The only difference from the regular working conditions was the method of taking the water from the tank, instead of directly from the condenser.

About 11 o'clock the feed-line blew out of the check valve in the feed pipe leading to the boiler and allowed considerable water to leak out, but enough of this was saved and weighed to allow of making a very close approximation to the actual test by leakage at this point. The same process was gone through with to find the loss at the pump. The length of line between boiler and engine is about 25 feet. The engine was not tested for steam leaks; and no leaks in piping of any account were noticed.

Indicator cards were taken from time to time during the test for the purpose of finding the horse powers developed. The speed of the engine varied from 140 rev. to 150 rev. per minute.

At the end of the test everything was brought as near as possible to the conditions that held at the beginning, the steam pressure being 100#, three pounds lower than the starting point, and the water 1/8" higher than in the morning. The test was closed at 4:47, nine hours after starting.

Copies of the log sheets and other tables of interest will be found at the end.

The results of the boiler trial are to be found in the following table. The amount of flower made was determined by the millers, but is with-held from publication, the result however was practically the same as that obtained from tests

[illegible] in this vicinity.

A sample of the feed water was taken from the boiler to steam the wheat. Making no correction for the amount of steam used in this manner, and none for that used by the pumps, the water consumption of the engine is approximately 32 # of water per horse power per hour.

The loss of pressure between the boiler and engine is attributed to the probable inaccuracy of the boiler gage, or to insufficient steam passages in the engine.

The lack of vacuum is probably due to obstructions in the passages to the condenser. All the delicate instruments used have been very carefully calibrated and are known to be correct.

I was assisted in the work by Messrs Newell and Newell.

Boiler Trial.

Duration of Trial.....6 hours.

Grate Surface	36 sq. ft.
Heating Surface, obtained from drawings	1470 " "
Ratio Heating Surface to Grate Surface	1 : .0245

Average Pressures.

Steam Pressure in Boiler by Gage	108.3 #
Absolute Steam Pressure	124.03 "
Atmospheric Pressure	14.23 "
Force of Draught in inches of water	0.385

Average Temperatures, Deg.

External Air	
Fire Room	89.3°
Temperature of Steam	83.5 "
Escaping Gases	343.57"
Feed Water	519. "
	145.4 "

Fuel.

Total amount Coal Consumed	4250 #
Moisture in Coal	2.5 %
Dry Coal Consumed	4143.75 #
Total Refuse	3.57 %
Total Combustible	3736.75 #
Dry Coal Consumed per hour	460.42 "
Combustible per hour	420.96 "

Quality of Steam per hour.

Quality of steam (dry steam taken as unity)	.973
Moisture in steam	2.7 %

Water.

Total weight of water pumped into boiler and apparently evaporated	27896 #
Water actually evaporated, corrected for quality of steam	27142.8 "
Equivalent water evaporated into dry steam from and at 212° F.	33126.8 "
Equivalent total heat derived from fuel in British thermal units	22132452.35
Equivalent water evaporated into dry steam from and at 212° F. per hour	3848.77 "

Work and Evaporation.

Water actually evaporated per pound of dry coal from actual pressure and temperature	3.55 "
Equivalent water evaporated per pound of dry coal from and at 212° F.	7.87 "
Equivalent water evaporated per pound of combustible from and at 212° F.	7.55 "

Rate of Combustion.

Lbs. coal of any kind per square foot of grate surface per hour 15.

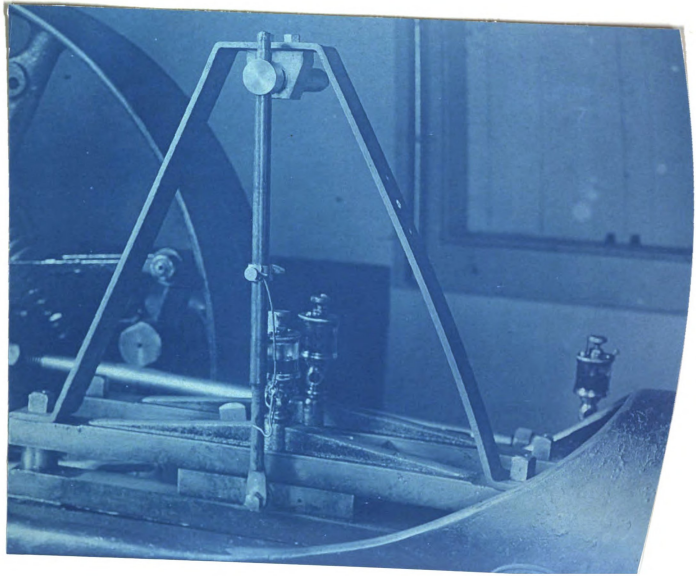
Rate of Evaporation.

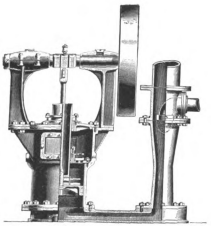
Water evaporated from and at 212° F. per square foot of heating surface per hour 2.53

Horse Power.

On a basis of 30 lbs. of water per hour evaporated from and at 212° F. with steam of 70 lbs. pressure 37

Horse Power, Uniform rating 110





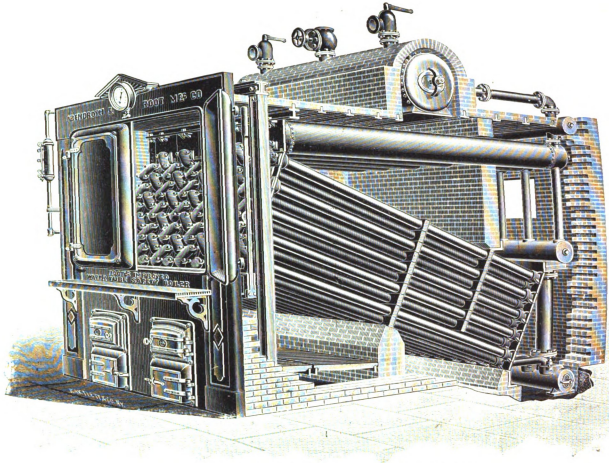
OPERATION.

The above cut shows a cross section through Air Pump and Condenser ☞ An examination of the engraving will clearly show the operation.

Steam coming down the exhaust pipe is met by the injection water, which is so thoroughly distributed by the spray, that condensation is effected with a minimum amount of water, and at the same time the overflow is heated to the maximum temperature.

The Air Pump is amply large to remove the greatest quantity of water used, with proper allowance for air It is single acting and is positively free from all air-locks, as the current of out going water is upward, and the air is allowed its natural tendency to rise.

The hot well is tapped so that connection can be made when discharge water is used for feeding boilers.



THE IMPROVED ROOT WATER TUBE BOILER.

LOG SHEET.

TIME	PRESSURES		TEMPERATURES				
	STEAM	DRAFT	BOILER ROOM	OUTSIDE	FLUE GASES	FEED WATER	WATER IN GLASS
7:47	110	.5" H_2O	30°C	23.5°	392° F	29°C	12.875
8:00	114		29	23.5	520	29	12.375
8:15	100		29.5	23	500	58	10.875
8:30	102	.75	29.5	23.8	524	58	11.75
8:45	111	.625	29.5	24	528	62	13.625
9:00	110	.5	30.5	24.5	498	61.5	12.75
9:15	105	.5	30.5	25	516	61	13.
9:30	115	.5	30	25	516	61	13.375
9:45	110	.5	30.5	25.5	504	61.5	13.25
10:00	112	.5	30.5	26	526	62	13.625
10:15	118		31.5	26	525	64	13.375
10:30	111		31	26	530	65	13
10:45	110	.75	30.5	25.8	512	64.5	12.75
11:00	107	.5	31.	25.5	516	64	11
11:15	109		31	26.2	511	64	13
11:30	110	.75	30.5	25.8	516	64.5	12.
11:45	119		31	26	546	64	12.75
12:00	105	.75	32	26.8	521	64	13.875
12:15	105		31.5	27	538	64	13.5
12:30	105	.5	31.	27.4	514	65	13.25
12:45	106				515	64	13
1:00	110				516	65.5	13
1:15	110				530	68	12
1:30	115				520	68.5	12.5
1:45	106				523	68.5	13
2:00	110				533	70	12.5
2:15	115		31.5	27	542	69	12.5
2:30	111	.5	32	27	523	66	13
2:45	110	.5	33	27.5	524	65.5	13
3:00	99		33	27.5	508	65	12.5
3:15	115		33	27.5	544	65	13
3:30	110		33	29	545	65.5	12
3:45	106		33.5	29	526	65	12
4:00	111	.625	33	29.5	532	67.5	13
4:15	110	.5	33.5	29	539	68	13
4:30	113	.625	34	29.5	538	68	13.5
4:47	107	.5	34	29	510	68	13

FEED WATER.

TIME.	POUNDS.	TEMP.	TIME.	POUNDS.	TEMP.
7:47	340	29 °c.	12:30	350	65 °c
8:00	325	29		350	
	340		12:45	350	64
8:15	309	58		350	
8:30	332	58	1:00	350	65.5
	325			350	
8:45	330	62	1:15	350	68
	330			350	
	340			350	
9:00	345	61.5	1:30	350	68.5
	345			350	
	353		1:45	350	68.5
9:15	325	61		350	
	350			350	
9:30	350	61	2:00	350	70
	350			350	
	350		2:15	350	69
9:45	350	61.5		350	
	350		2:30	350	66
10:00	350	62		350	
	350			350	
10:15	350	64	2:45	350	65.5
	350			350	
10:30	350	65		350	
	350		3:00	350	65
10:45	350	64.5		350	
	350		3:15	350	65
11:00	350	64		350	
	350		3:30	350	65.5
11:15	350	64		350	
	350		3:45	350	65
11:30	350	64.5		350	
	350		4:00	350	67.5
	350			350	
11:45	350	64.		350	
	350		4:15	350	68
	350			350	
12:00	350	64	4:30	350	68
	350			350	
12:15	350	64		350	
	350		4:47	167	68.
	350				

CALORIMETER.

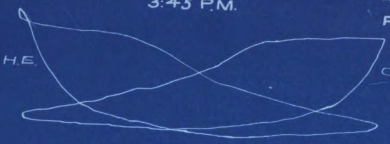
TIME	P	P_1	T_d
9:45	112#	14#	239.8
9:50	110	13	252.3
10:00	108	15	250.1
10:05	106	15	257.0
10:10	110	15	257.9
10:15	111	15	259.3
1:10	112	15	263.3
1:15	111	15	263.8
1:20	119	15	265.1
1:25	110	15	266.0
2:10	120	16	266.9
2:15	115	15	266.9
2:20	104	142.5	266.0
2:25	110	16	264.7
4:15	110	15	266.0
4:20	115	16	266.0
4:25	112	15	267.4

INDICATOR CARDS.

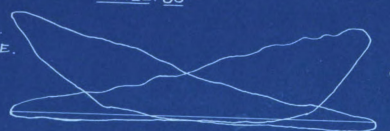
TIME	LENGTH		AREA.				M.E.P				I.H.P		REV.
	H.P	L.P	H.P.H.E	H.P.C.E	L.P.H.E	L.P.C.E	H.P.H.E	H.P.C.E	L.P.H.E	L.P.C.E	H.P	L.P	
11:45	4"	3.875	1.96	1.95	1.48	2.05	29.4	29.25	7.64	10.55	49.27	47.96	150
1:30	3.875	3.875	1.86	1.93	1.51	1.9	28.8	29.87	7.78	9.8	48.6	44.87	148
2:05	3.84	3.875	1.9	1.98	1.52	2.01	29.68	30.93	7.84	10.89	50.56	48.11	149
3:15	4"	3.875	1.9	1.96	1.51	1.91	28.5	29.4	7.78	9.86	47.48	45.31	149
3:45	3.875	3.875	1.78	1.93	1.6	1.82	27.53	29.88	8.26	9.39	46.96	44.34	146

REV. = 146.
VAC. = 17.5.
PRES. = 108#

3:45 P.M.



SCALE: 60#



SCALE: 20#

COAL.

TIME	LBS.	TIME	LBS.	TIME	LBS.
7:47	300	10:58	350	2:15	300
8:25	300	11:35	300	2:45	300
9:06	300	12:15	300	3:30	300
9:40	300	1:00	300	4:15	300
10:15	300	1:30	300		

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